SETTING THE STANDARDS
15 YEARS

Bonus International Editorial Section FOLLOWS PAGE 64

BYTE

JUNE 1990

A McGRAW-HILL PUBLICATION

Cheetah's 33-MHz 486

High speed from hot cycles and ultrafast memory

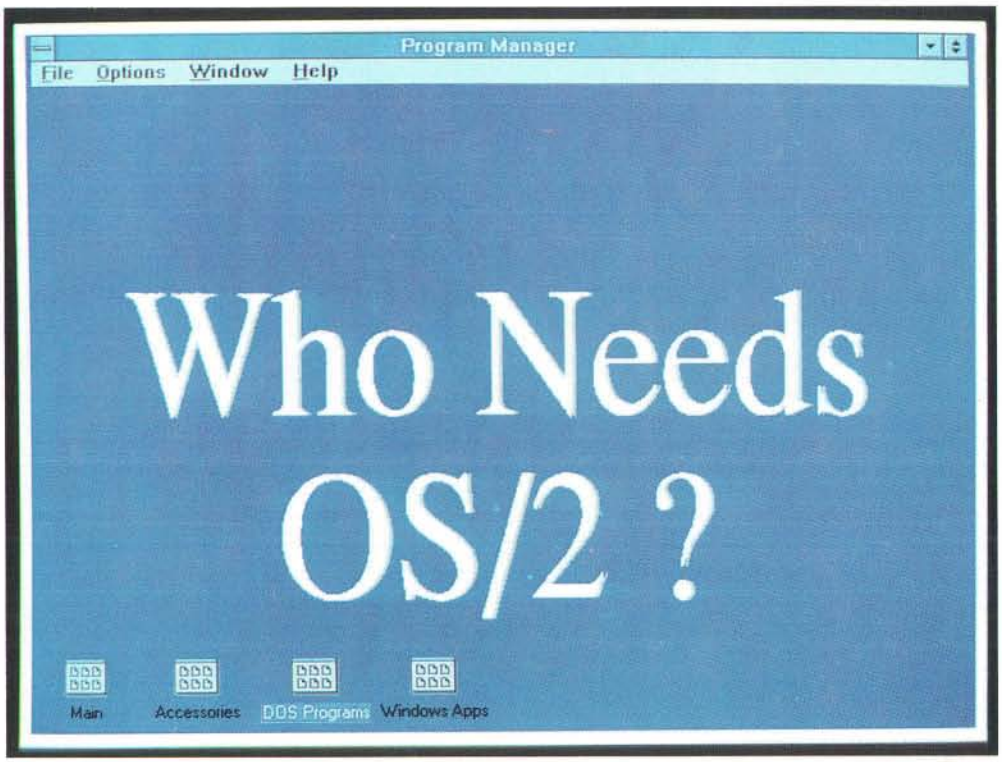
DOS will never be the same

Windows 3.0

- Sun's New SPARCStation SLC
- State of the Art: Networking
- Low-cost peer-to-peer LANs
- Linking DOS and Unix
- ESDI Disks
- Data Encryption

PLUS

- Lotus Magellan 2.0
- Modular 486s from AST and ALR
- Mac PageMaker 4.0
- A VGA Multimedia Board
- Borland's New Turbo Debugger
- Full Impact 2.0



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- DOS switcher
- V86 multitasker
- virtual memory manager

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PC MAGAZINE EDITORS' CHOICE 11-29-88

THE DELL SYSTEM® 310
20 MHz 386.

The best combination of performance and value in its class.

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- Intel 80386 microprocessor running at 20 MHz.
- Standard 1 MB of RAM, optional 2 MB or 4 MB of RAM* expandable to 16 MB (using a dedicated high speed 32-bit memory slot).
- Advanced Intel 82385 Cache Memory Controller with 32 KB of high speed static RAM cache.
- Page mode interleaved memory architecture.
- VGA systems include a high performance 16-bit video adapter.
- Socket for 20 MHz Intel 80387 or 20 MHz WEITEK 3167 math coprocessor.
- 5.25" 1.2 MB or 3.5" 1.44 MB diskette drive.
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40 MB TTL Monochrome System	$3,299
40 MB VGA Color Plus System	$3,799
100 MB VGA Color Plus System	$4,399
100 MB Super VGA Color System (800x600)	$4,499

Prices listed reflect 1 MB of RAM. 80, 150 and 322 MB hard drive configurations also available.

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16 MHz 386SX.

The perfect low profile mainstream computer, combining 386SX power and compatibility with unprecedented value and support.

STANDARD FEATURES:

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100 MB Super VGA System (800x600)	$3,099

Prices reflect 512 KB of RAM. 640 KB versions of the above systems are available for an additional $50, 1 MB versions for an additional $150, and 2 MB versions for an additional $300.
80 and 170 MB configurations also available.

PC MAGAZINE EDITORS' CHOICE 3-13-90

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- 3.5" 1.44 MB diskette drive.
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PC WORLD BEST BUY

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STANDARD FEATURES:

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- Page mode interleaved memory architecture.
- LIM 4.0 support for memory over 640 KB.
- Integrated diskette and high performance 16-bit VGA video controller on system board.
- Socket for Intel 80287 math coprocessor.
- 5.25" 1.2 MB or 3.5" 1.44 MB diskette drive.
- Integrated high peformance hard disk interface on system board.
- Enhanced 101-key keyboard.
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- Advanced Intel 82385 Cache Memory Controller with 32 KB of high speed static RAM cache.
- Page mode interleaved memory architecture.
- VGA systems include a high performance 16-bit video adapter.
- Socket for 25 MHz Intel 80387 or 25 MHz WEITEK 3167 math coprocessor.
- 5.25" 1.2 MB or 3.5" 1.44 MB diskette drive.
- Dual diskette and hard drive controller.
- Enhanced 101-key keyboard.
- 1 parallel and 2 serial ports.
- 200-watt power supply.
- 8 industry standard expansion slots (6 available).
- 12-month On-Site Service Contract provided by Xerox.△

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PC MAGAZINE EDITOR'S CHOICE 2-14-89

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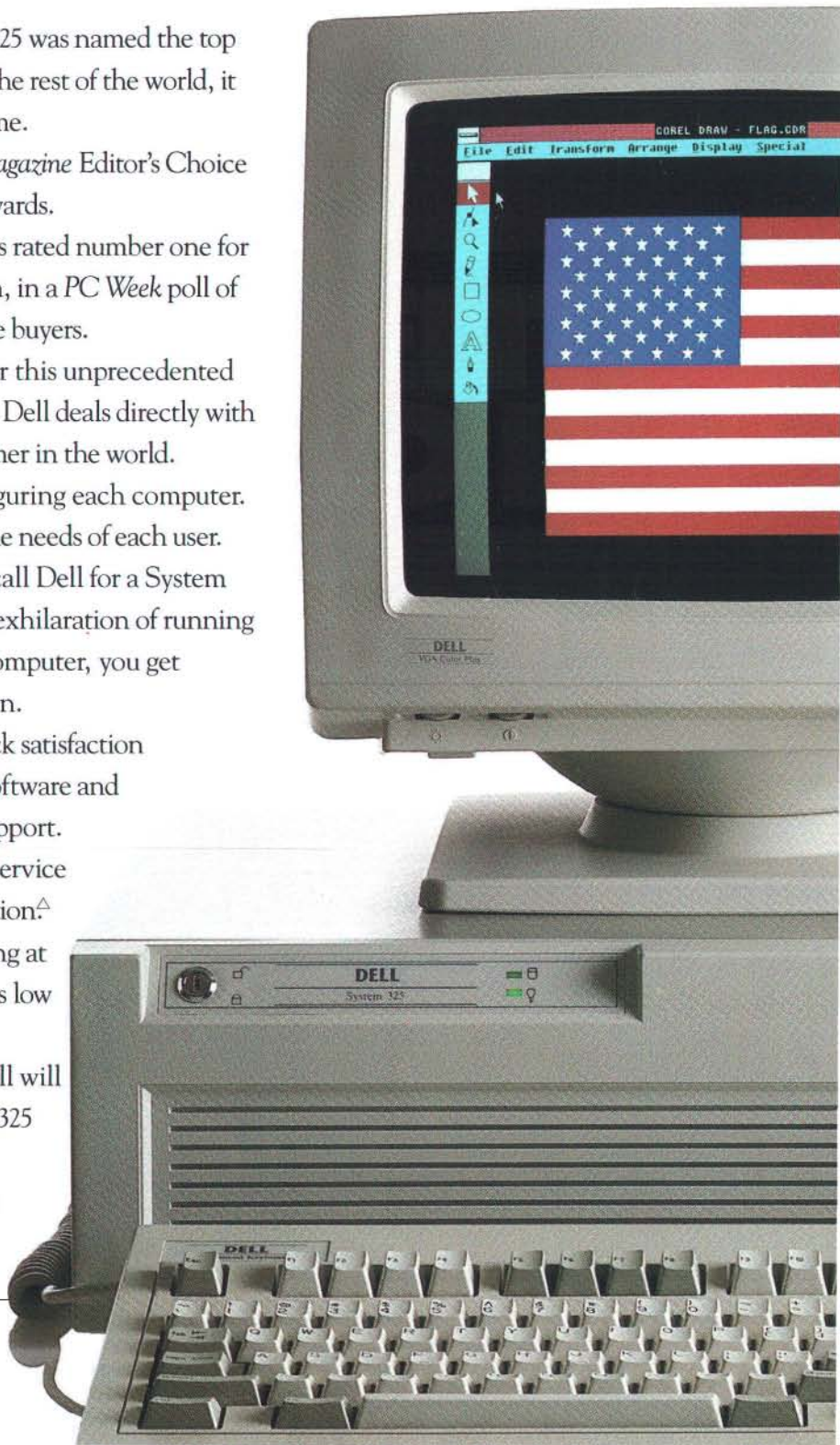

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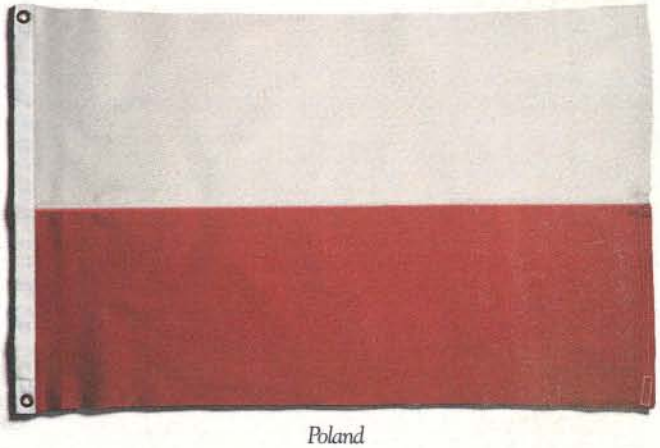

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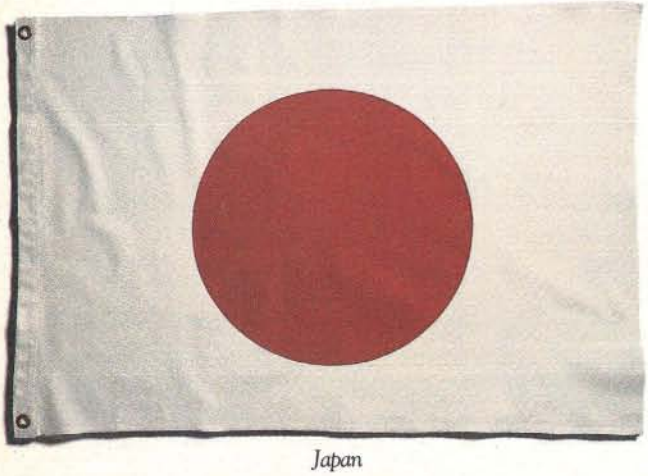

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Italy

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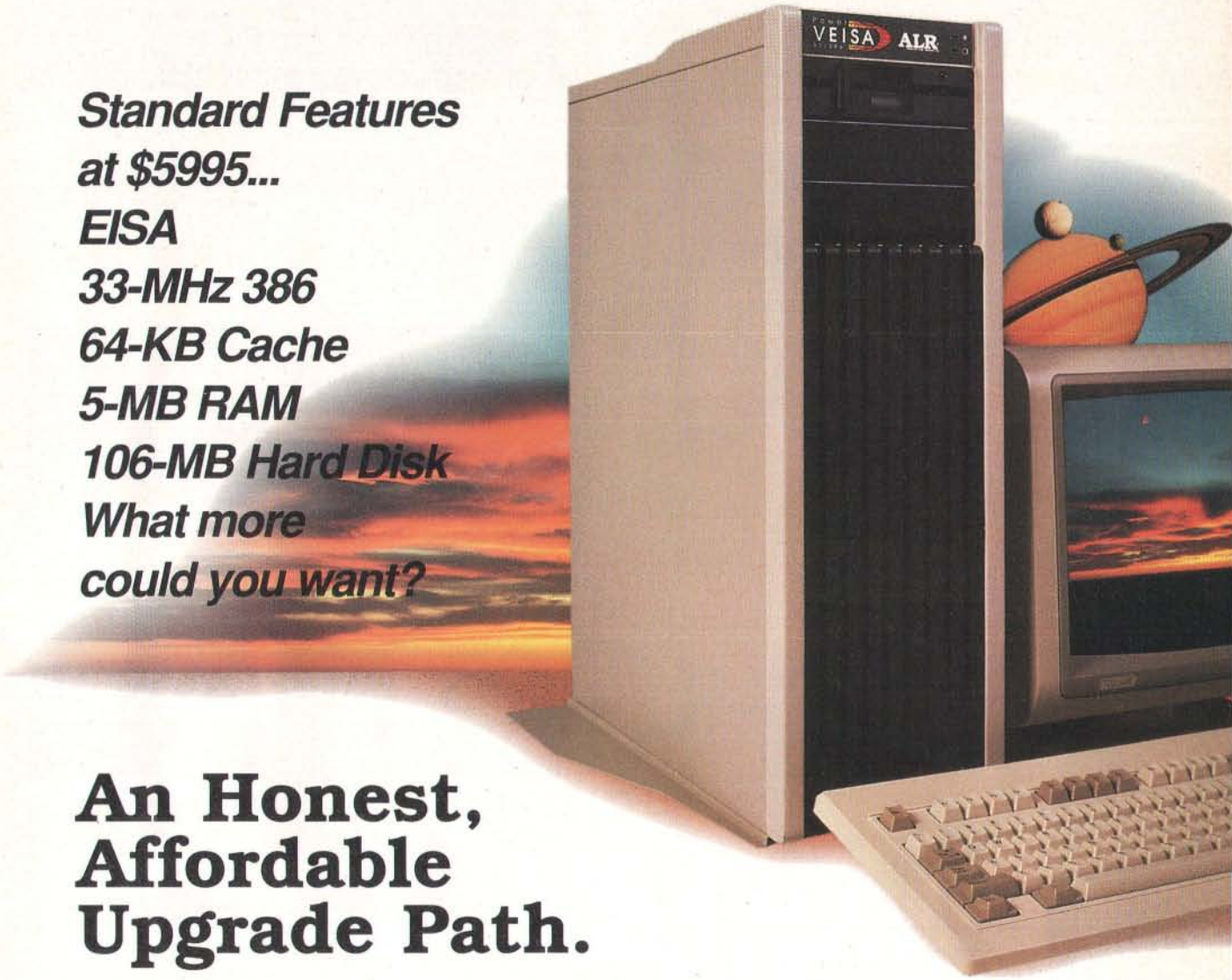

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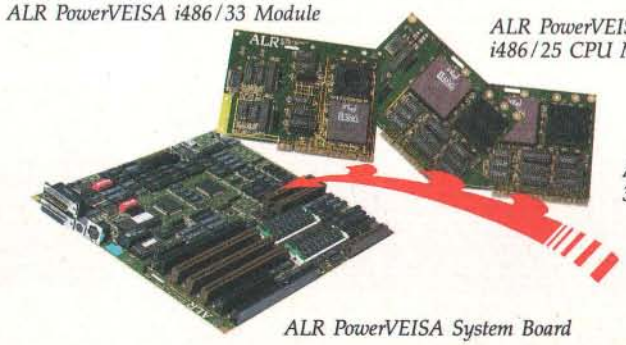

Prices and configurations subject to change without notice. Shown with optional monitor. Prices based on U.S. dollars.

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106-MB Hard Drive	110-MB Hard Drive
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Optional VGA	VGA
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i486 25-MHz Upgrade add $1995	i486 25-MHz Upgrade add $2995
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$8,285	$12,740

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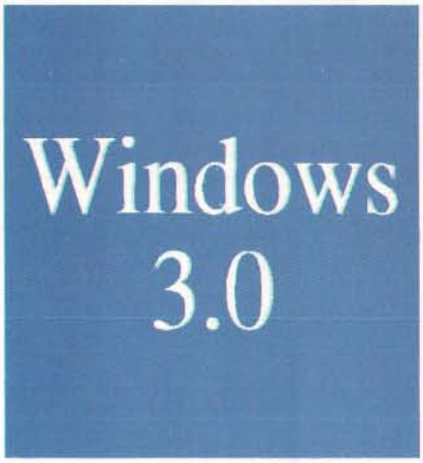

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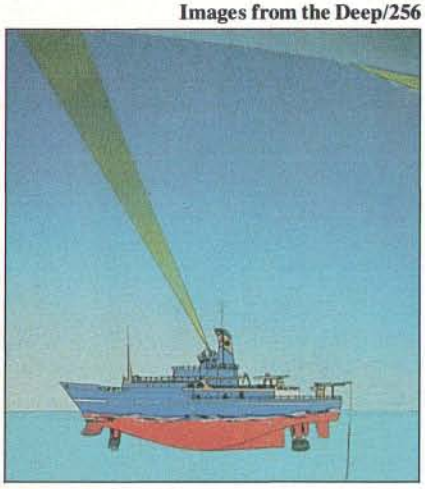

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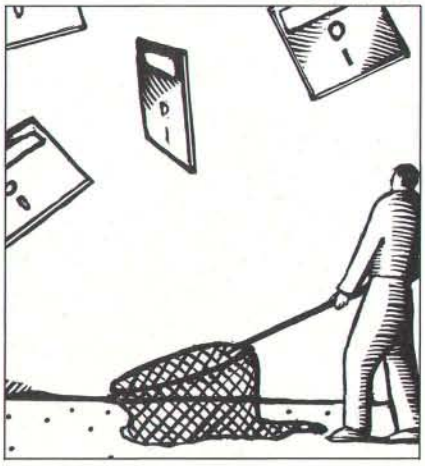

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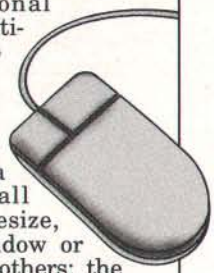

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THE NEWS IN REVIEWS

A redesign for the reviews section and a look at yesterday and today

We have made a couple of changes in our product reviews this month. Most obviously, we've redesigned the reviews section. Less noticeable, unless you read magazine mastheads, is that all staff involved in reviewing products are now part of the BYTE Lab.

Our redesign goals were simple: Make the reviews appear as their own section rather than as individual articles, saving precious column inches in the process; and allow more flexibility for photos, figures, text boxes, and other means of enhancing the basic evaluation. Art director Nancy Rice and assistant art director Joe Gallagher deserve credit for achieving those goals.

Placing what was previously called the BYTE reviews department under the BYTE Lab moniker emphasizes the importance and seriousness that BYTE places on the product evaluation process. We use the same tried-and-true review procedures we did before, and that has always involved everyone who is now part of the BYTE Lab. The name change makes that clear.

You'll also notice the BYTE Lab logo appearing in each review. That logo means that the product has been evaluated by BYTE Lab standards. It also serves to distinguish BYTE reviews from our Short Takes and First Impressions, which are not full evaluations but early looks at upcoming products.

You are the beneficiaries of these changes. We hope you'll find BYTE's reviews more useful and enjoyable as a result. If not, drop us a note telling us why.

The Father of Computer Graphics

Today, we take the idea of a graphical user interface for granted. But 15 years ago, the technology was restricted to advanced research and military systems. And 15 years before that, the idea that a person could use a computer *interactively* was unheard of. Then, an MIT student came up with an innovative doctoral project, a system that laid the foundation for today's interactive computer graphics. This month's fifteenth anniversary special tells the intriguing tale of Dr. Ivan Sutherland and his trailblazing graphics system, Sketchpad.

R&D Consortia

Computer technology is one of the few areas where the U.S. holds an edge over its global competitors. But that lead is in danger of slipping away in the face of Japanese enterprise and a united Europe.

As in other high technology areas, a few U.S. companies are "circling the wagons"—joining together in R&D consortia that aim to provide them with a competitive edge. Technical editor Janet J. Barron takes a look at the current state of computer consortia in her article "Consortia: High-Tech Co-ops" on page 269.

—Michael Nadeau and Kenneth M. Sheldon

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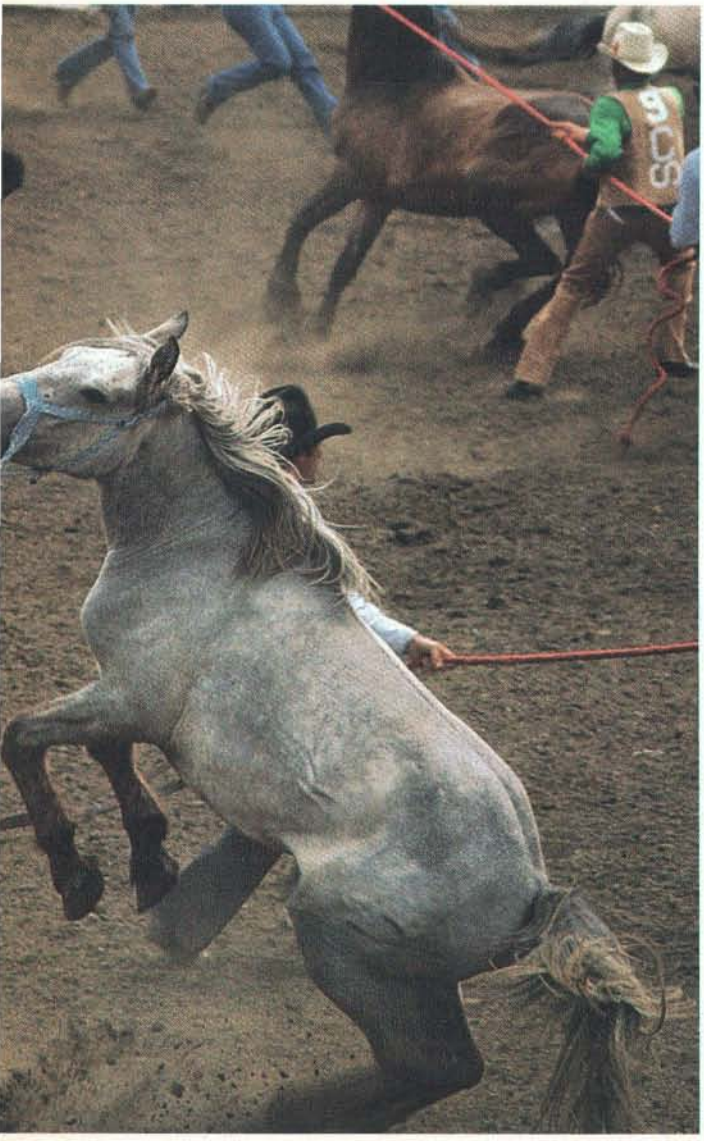

What's more, these products are based on the Microsoft Windows environment, an approach that's not only inherently easy to use, but rapidly becoming the industry standard.

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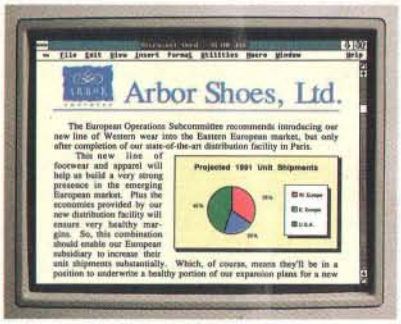

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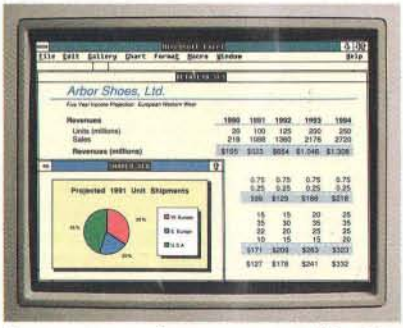

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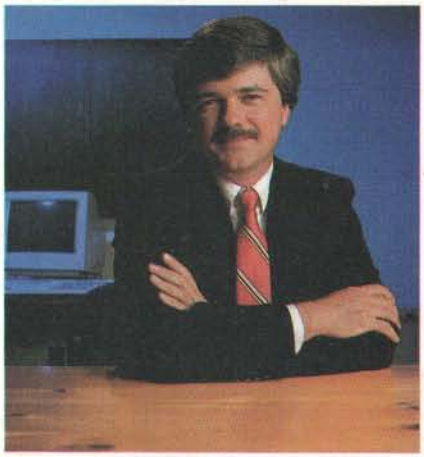

TAIWAN, THE SOVIET UNION, AND YOU

These countries may be a major factor in your computing options for the 1990s

Taiwan and the U.S.S.R. are about as different as can be. Taiwan is only three times the size of Connecticut. The U.S.S.R. is the largest country on earth. Taiwan has a tropical, marine climate; the U.S.S.R. has many climate areas, but it tends toward the cool temperate and colder. Both countries are becoming increasingly important players in the world of computers.

For example, it's an almost certain bet that major chunks of your desktop system came from Taiwan—and not just chips and small parts. Taiwan is the world's number-one supplier of monitors and is number two in producing terminals and number three in building complete microcomputer systems. It's also a major source of disk drives, add-in cards, printers, and other peripherals.

In 1988 (the last year for which I have export numbers), Taiwan's computer products exports reached well over $1.2 billion (in U.S. dollars), double what it was just two years previously. And that figure is still climbing.

Each year, the Taiwanese government sponsors a huge computer trade show called Computex. The show is roughly the size of Comdex here in the U.S.—but when you consider the relative sizes of Taiwan and the U.S., you see that proportionally, Computex is staggeringly large.

I'll be attending Computex in June, and spending a week meeting with officials of the government and the leading computer companies there. In a future issue, I hope to tell you what new products and technologies I've learned of, and what impact this Asian powerhouse is likely to have on the computer industry and on the range of products and prices available to us.

Back in the U.S.S.R.

At the other end of the computing spectrum, the U.S.S.R. isn't the number-one supplier of anything. Or the number two. Or the number three. . . .

But the Soviets do have a vast hunger for computer products and a tremendous untapped resource of world-class programming talent.

In an earlier editorial ("The Russians Are Coming," October 1988), I wrote about one of the earliest efforts to export Soviet business software to the West: Members of the U.S.S.R. Academy of Sciences toured the U.S. looking for interest in their generic "software factory."

The "factory" is a collection of modules ranging from a natural-language database to equation solvers to financial modelers. With a minimum of programming, you can customize modules in the factory to solve a very wide range of problems: Feed data—almost any data—into the system, select and program the appropriate modules, and get your answers out the other side.

The factory was creative, innovative, cleverly done, and quite unlike anything I'd seen before. The Soviet programmers had produced an amazingly complex problem-solving environment from the ground up—despite a lack of access to the tools we're familiar with, and despite the forced necessity of working with relatively underpowered hardware. For example, they needed a better way to build and manage the modules, so they created a new language that's sort of an object-oriented Prolog.

Along the way, they needed a Cyrillic word processor, so they wrote a program that easily equals many that are in use in the West. And all their code had to be tight and efficient because it had to run on, at best, 12.5-MHz IBM PC AT clones.

Of course, Soviet programmers work on more than just large-scale projects: Alexey Pazhitnov has become the U.S.S.R.'s first (and so far only) software cult hero on the strengths of his Tetris and Welltris game software.

Clearly, there's plenty of software talent in the U.S.S.R., and if the obvious economic obstacles can be removed, the U.S.S.R. could become a world player in software by the middle-to-late 1990s.

But the obstacles are severe. BYTE columnist Jerry Pournelle (who recently was voted the most popular computer columnist in the U.S.S.R.) visited the U.S.S.R. this April, just before the Lithuanian economic blockade, and reports that "there are lots of business opportunities, if only you can figure a way to get your share of the profits out of the country." You can't take rubles out of the U.S.S.R., nor readily convert them to another currency.

Besides discouraging outside involvement and investment, it makes things hard on the Soviets, too. Jerry reports that the academicians and other professionals he met in the U.S.S.R. all make about 300 rubles a month. At the "official" rate of about 6 rubles to the dollar, or the real-world rate of about 20-to-1, this salary works out to somewhere between $15 and $50 (U.S.) per month. You can see why so few Soviets have ready access to personal computers, and thus why their talents lie mostly fallow.

That may all be changing—although events in the U.S.S.R. are fluid and very hard to predict. Assuming that conditions still allow for travel from the West, I'll be spending a week in Moscow as a guest of the International Computer Club, at its first post-glasnost meeting in mid-June.

It should be a fascinating trip. Stay tuned.

—Fred Langa
Editor in Chief
(BIX name "flanga")

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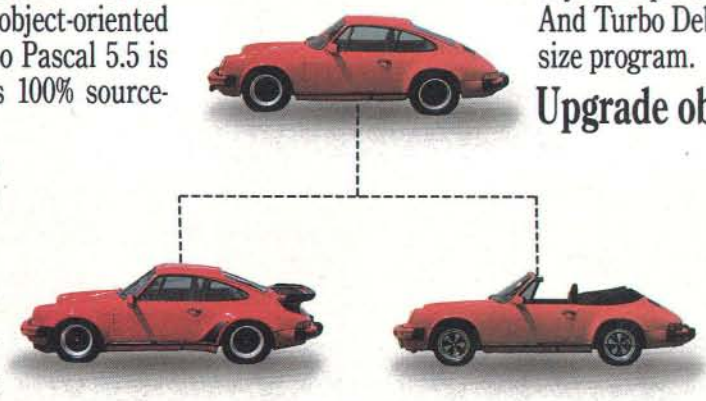

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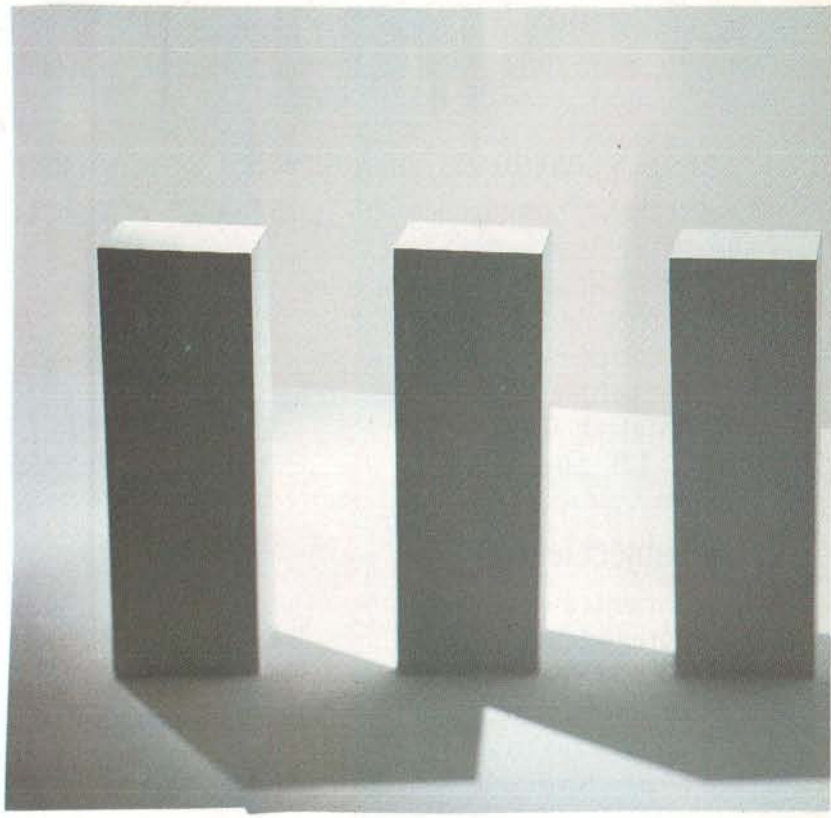

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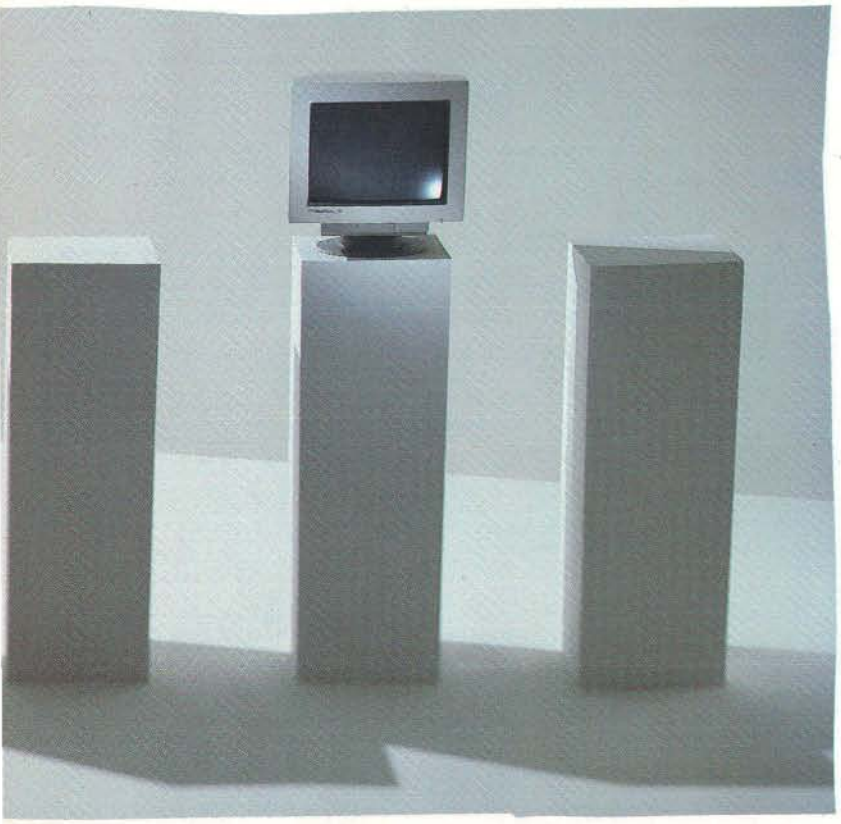

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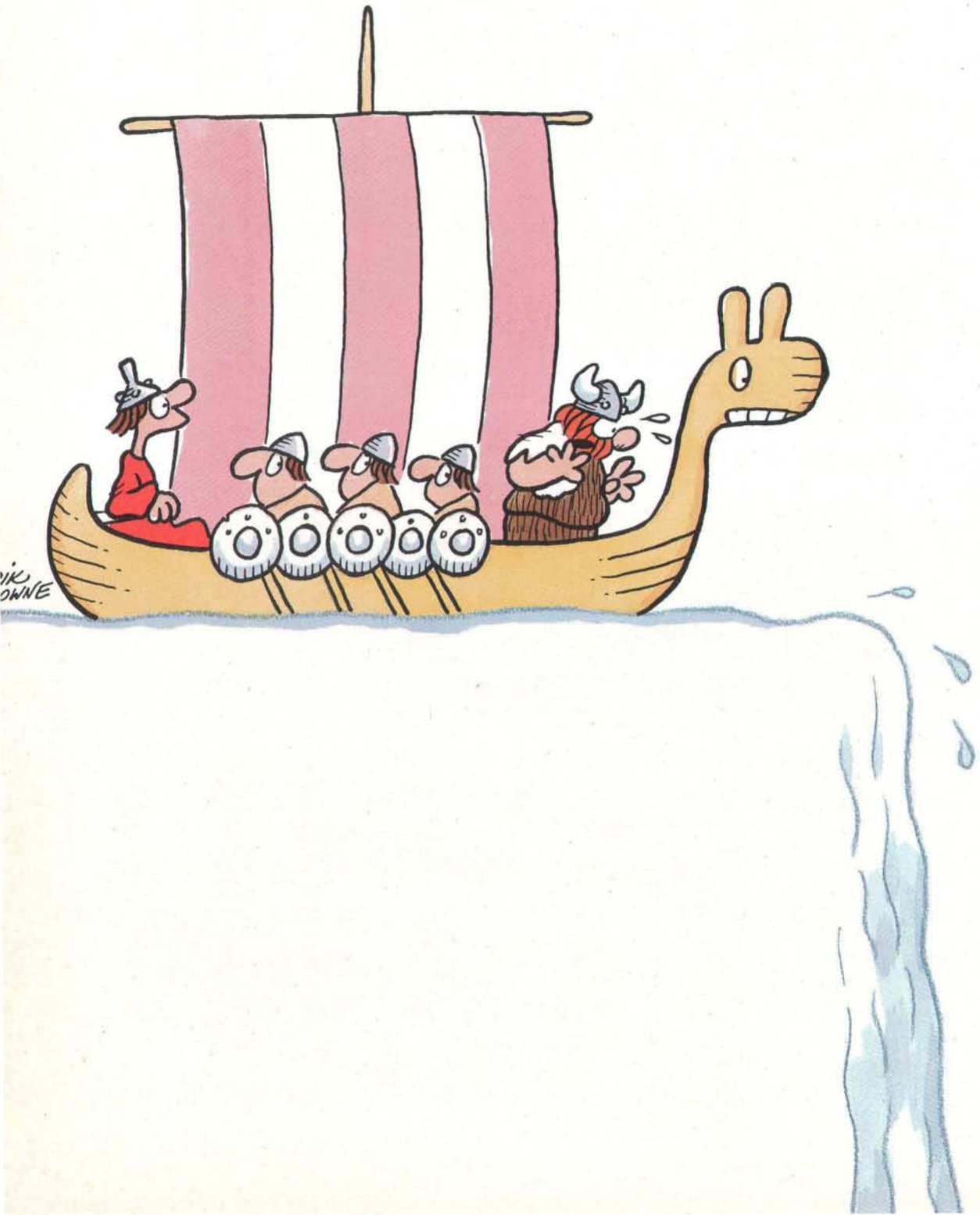

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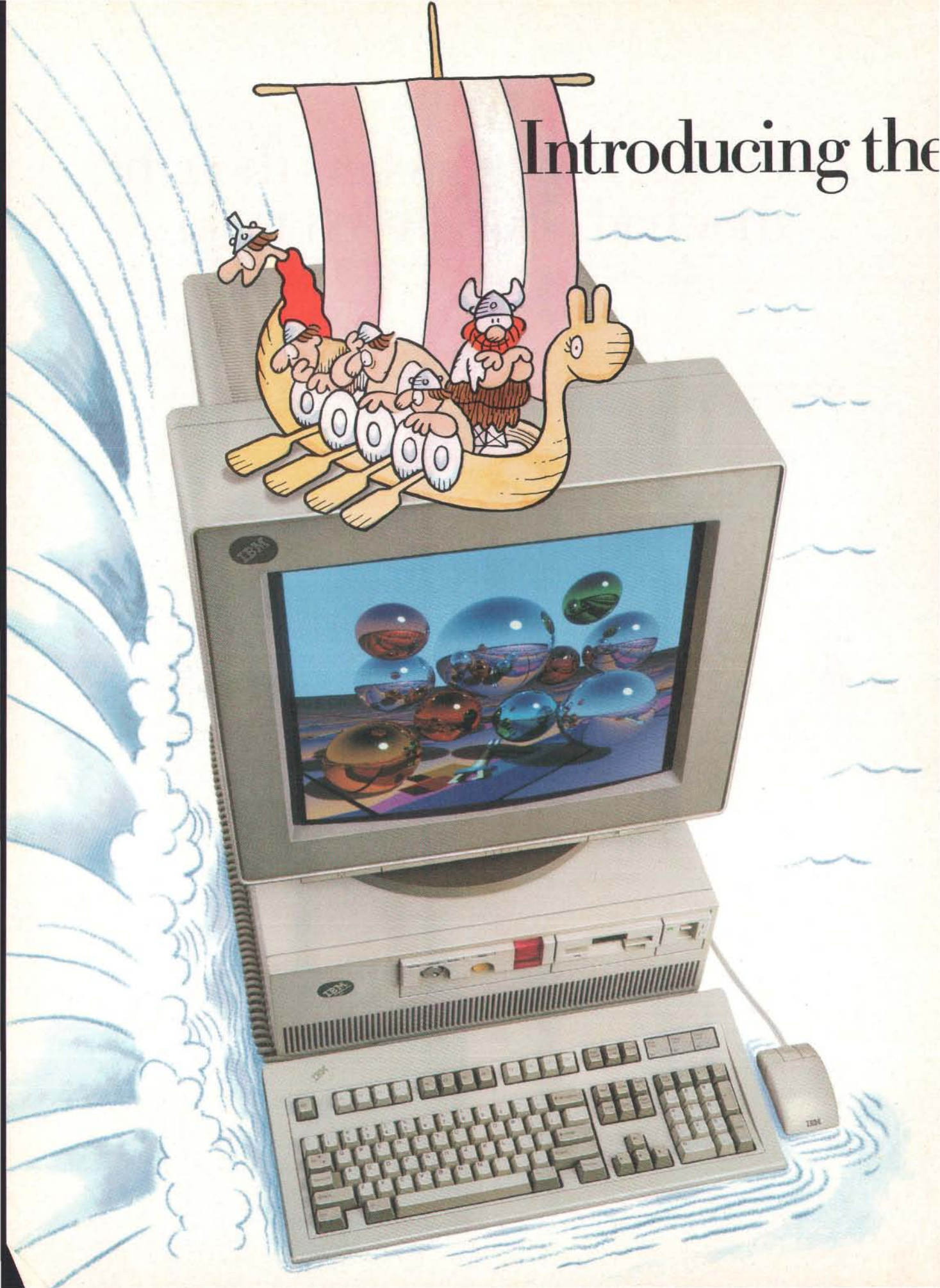

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†MFLOPS are the results of the double-precision, all FORTRAN Linpack test 100 x 100 array suite. The Dhrystone Version 1.1 test results are used to compute RISC System/ 6000 Integer MIPS values where 1,757 Dhrystones/second is 1 MIPS (VAX 11/780). SPECmark is a geometric mean of ten benchmark tests.
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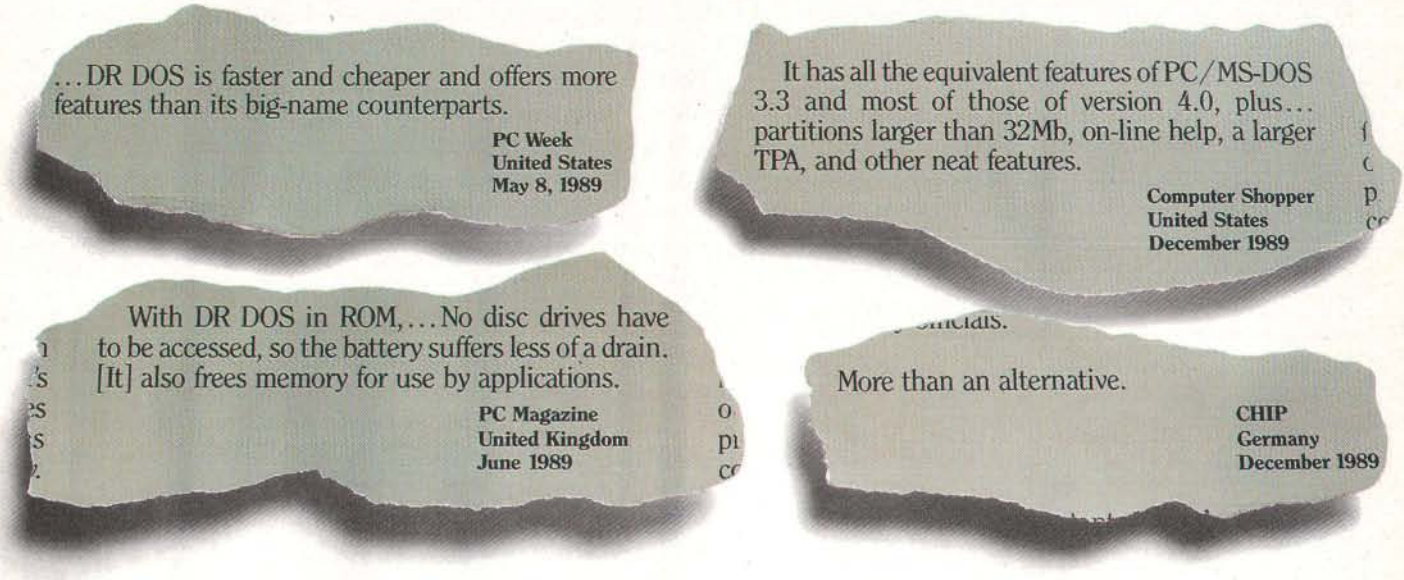

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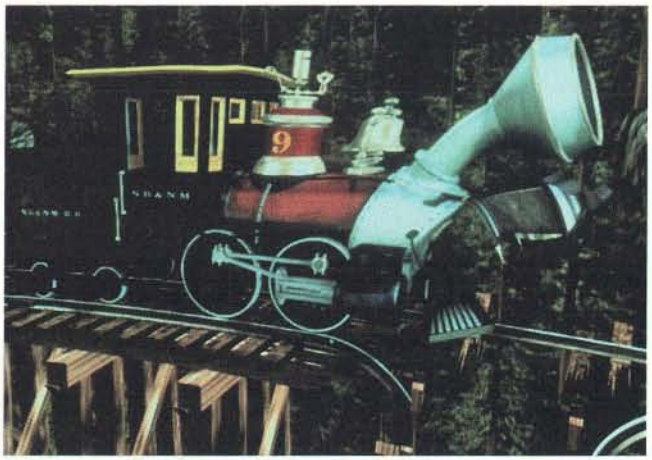
MICROBYTES

Research news and industry developments shaping the world of desktop computing
Edited by D. Barker

NCGA Report: Great Graphics Coming Down

Scanning the big picture at the recent National Computer Graphics Association show, it was clear that personal computers are becoming more popular as tools for producing dramatic, high-quality graphics. Workstation makers were there in spades, but they were outnumbered this time by vendors with products that enable personal computers to quickly generate sharp and colorful images.



"Locomotion," generated by Pacific Data Images, was a winner in NCGA's computer animation competition.

Powerful graphics processors and display controllers are helping turn relatively low-cost computers into machines that rival more traditional dedicated graphics systems. Perhaps the most bodacious of the new, inexpensive graphics coprocessors is Texas Instruments' 34020, which the company says is three to 20 times faster than its predecessor, the 34010, at on-chip graphics operations. Even more powerful than the TI chip is Intel's i860, a RISC processor torqued for graphics functions. Evidence at NCGA showed that hardware designers are now picking up on the i860, and products using it will become prevalent soon.

Photo-realism is no longer the province of computers that only defense contractors and movie studios can afford. Although they're still very expensive, tools like RenderMan and HOOPS are empowering users with capabilities to generate realistic, three-dimensional images.

Judging from comments from users and the size of crowds at certain exhibits, this year's NCGA made it clear that people want sharp, colorful, and realistically rendered graphics. As the following stories report, vendors are responding with the necessary tools.

NCGA

For Realism, Developers Calling RenderMan

Creating photo-realistic images requires tools for simulating surface textures and lighting effects. If Pixar (San Rafael, CA) has its way, "appearance libraries" of fabric, cement, stucco, wood, plastic, and other materials, as well as "shaders" for specifying lighting effects, will become standard tools for architects and artists who require photo-realism in their computer-aided designs. And all these tools will be based on the RenderMan specification for scene descriptions, in much the same way that the PostScript standard is used for defining characters in desktop publishing. Pixar will soon release a sample appearance library and is working with third-party developers to produce more catalogs.

At the recent National Computer Graphics Association show, there was evidence that RenderMan is starting to catch on. Pixar introduced its first end-user implementation of RenderMan,

continued

NANOBYTES

Is **NewWave** gaining momentum? **Hewlett-Packard** (Cupertino, CA) has recently licensed its Windows-based graphical environment to several major companies, including AT&T, which is using it with the Rhapsody workgroup package. Lotus said that it will work with HP to get 1-2-3 release 2.2 running under NewWave. NCR, Data General, and Canon have also signed licenses to use NewWave. And any day now, quite a few developers say, companies will start shipping applications that work with NewWave, including a graphics package and some multimedia authoring tools from Aimtech, a database program from Palantir, an E-mail program from Da Vinci Systems, development tools from Glockenspiel and Candlelight, communications packages from HP and Micro-View, and a version of Amí Professional from Samna.

NeXT users have been wondering when something like **HyperCard** will come to the cube. It should be later this year. **Thoughtful Software** (Fort Collins, CO) hopes to ship its "HyperCard-like" HyperCube software during the fourth quarter, our sources say.

Despite having created CP/M and the GEM operating environment, **Digital Research** (Monterey, CA) has an identity problem. "Despite our best efforts, there are still people who haven't heard of us and who don't know what we do," says company president Dick Williams. He wants to make DR into a "more friendly and approachable" company and to **focus more on applications** software, including programs for Windows, OS/2, Unix, and the Mac. One of DR's biggest hits is DR DOS, an enhanced and ROMable version of MS-DOS; the company says that it has licensed more than 3 million copies.

NANOBYTES

U.S. software houses saw sales go up 12 percent last year, according to a new report from the Software Publishers Association (Washington, DC). Fourth-quarter sales totaled $916 million, the SPA estimates. Word processors were the biggest seller. The North American applications software market was worth about $3 billion last year, according to SPA reckoning.

U.S. software companies also had **a good year overseas**, with aggregate sales up 46 percent over 1988, the SPA says. The biggest growth rates were in Spain, Portugal, and Italy. The SPA bases its figures on data submitted to the Arthur Anderson accounting firm by 20 prominent software companies, including Borland, WordPerfect Corp., Lotus, Ashton-Tate, Claris, and Persoft.

Aox (Waltham, MA) will work with IBM to develop **bus-mastering products** for Micro Channel systems. Aox already offers bus-master upgrade boards for Micro Channel PS/2s. The MicroMaster boards turn a 286- or 386-based PS/2 into a 386- or i486-based system and assign the original CPU to handle low-level tasks. IBM is investing money in Aox, as well as buying a "substantial" number of MicroMasters for internal use, Aox says.

Structured Query Language has been a quasi-standard in the relational database world. Although the syntax is fairly standard between different companies, the semantics can vary. The **SQL Access Group** has completed its initial technical specification for what it hopes will be a standard SQL that all database vendors could use. If their proposal becomes established, programmers will be able to write to a **common interface** for almost all SQL systems. Group members include Oracle, Informix, Ingres, Ashton-Tate, and DEC. One of the group's focal points is the communications involved in distributed databases. An ANSI committee is also working on a standard SQL.

called MacRenderMan, and several companies showed Macintosh programs that support it, including MacroMind (Three-D) and Paracomp (Swivel 3D). Until now, RenderMan has been available only as a developer's toolkit, requiring knowledge of C programming.

MacRenderMan ($795) will allow images generated with those packages to be given visual attributes such as texture, shading, blurred motion, and other special effects. The resulting image is stored in a standard file format called the RenderMan Interface Bytestream. In theory, the user should be able to change attributes—wood to marble, for example—as easily as a PostScript user can change fonts. According to Dan Ahlberg, product manager for MacroMind Three-D, RenderMan is "analogous to going from a LaserWriter to a Linotronic [typesetter]. You get higher quality and extendability."

Other companies supporting RenderMan include Levco, which at NCGA had RenderMan running on an accelerator board; CADkey, which announced CADkey Render for its eponymous CAD program; Evolution Computing, which has a new version of FastCAD, called FastCAD 3D, that's bundled with RenderMan; Strata, which plans to have its StrataVision 3D software work with RenderMan; and Sun Microsystems, which announced a "visualization" product, called SunVision, that has a RenderMan-compatible interface for rendering images.

More companies are expected to go with RenderMan this year. According to Pixar's Tom Porter, Autodesk plans to release a version of AutoCAD that supports RenderMan. NeXt has said that it will support RenderMan on its color computer, to be introduced later this year. IBM endorsed RenderMan and is likely to offer products based on the specification.

Although RenderMan is gaining popularity, rendering is expensive. RenderMan requires at least 4 MB of memory, and it prefers 8 MB. On top of that, you need vast amounts of disk-storage space and high-resolution color graphics. And to achieve acceptable performance, you need either a personal computer with a graphics accelerator or a workstation such as the Sun SPARCStation or Silicon Graphics Personal Iris.

—Nick Baran

NCGA

Intel's i860 Engine Picking Up Steam

Judging from news at the National Computer Graphics Association show, Intel's i860 RISC processor is finding its destiny in the demanding world of three-dimensional and high-resolution graphics. Giving Intel one of the best testimonials yet for its chip with the built-in 3-D engine, Hewlett-Packard (Palo Alto, CA) announced that it will develop new graphics technologies using the i860. The company demonstrated an experimental i860-based "graphics transform engine" installed in an HP-3000 workstation, handling full-color antialiasing, contour mapping, ray tracing, and other graphics functions. This engine, which HP says will show up in future workstations, will include hardware support for some of the most difficult 3-D algorithms. The graphics engine will connect to the workstation's main CPU and memory via a 30-MBps link. HP says that this new hardware will perform most operations either in real time or so quickly that the user will hardly have to wait. Perhaps the most interesting part of HP's approach is the degree to which difficult rendering operations will be moved from software to hardware.

Matrox (Dorval, Quebec, Canada) displayed working prototypes of an i860 parallel processing board designed to speed up floating-point operations. The board is built for computers with the Extended Industry Standard Architecture bus and makes use of EISA's bus-mastering capability to operate independently of the host system. The MP-860, which holds one 40-MHz processor and 2 MB of memory (expected price: $6300), can run floating-point and computationally intensive applications up to 100 times faster than a 386-based system with an 80387 coprocessor, Matrox claims. You'll be able to connect as many as eight of the boards in a single system and have them operate concurrently. To communicate, the boards use their own high-speed bus, called the TransMemory bus, that can transfer 100 MBps

continued

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Ray: Me neither. Don't you s'pose we could hire somebody to write our ads? *(Laughter.)*

Ted Waitt, President

Ted: No, because we've always been straight forward in our advertising. I've analyzed the market and I can't understand why anyone would buy a computer from anyplace except Gateway. Now I know you all agree with me, so I want you to tell the world what you can do for them. Just straight talk from a friend in the business. I'm recording this —

Troy: Is this legal?

Ted: — and I'm gonna give the tape to word processing for a transcription. And that's going to be our ad.

Norm: This oughta be good! (Laughter).

Ted: Todd, you're on. I'm looking for a computer system. Why should I buy from Gateway 2000?

Todd: Because Gateway has the best value. We lead the market in price, quality and service. It's that simple. You wanta get the best system for the best price from a company you can depend on? Then buy from Gateway 2000.

Troy Miller, Plant Manager

Todd Osborn, Sales Manager

Troy: Yeah, shop around. But don't be fooled by stripped-down systems. Compare Gateway feature for feature and we blow the competition away.

Norm: And read the reviews. Our systems out-perform machines that cost twice as much.

Ted: Troy, you're on. You run the plant so you tell me what kind of quality I can expect.

Troy: Well we use a component that's not very common today — *pride*. Each machine that goes out the door is custom-built by one person. That person's pay is determined by how satisfied you are as a customer. We use only top-of-the-line components. You combine that with the midwest work ethic and you've got an unbeatable combination.

Ted: OK, Gateway's got great prices on quality systems. But we can't guarantee everyone that they'll never have a problem.

Ray: If we could, I'd be out of a job. *(Laughter.)*

Ted: Yeah, Ray. Tell me about your job. What happens if a customer does have a problem?

Ray: That's where we shine. Gateway's tech support is the best in the industry. We know what we're talkin' about, but most importantly, we care. We'll bend over backwards to take care of you. You won't hear us saying, "Sorry ma'am, that's a software problem." We don't care whose problem it is. If the machine is not working for you, we'll do everything in our power to get you up and running.

Norm Waitt, Vice President

Ted: What if you can't fix a problem over the phone?

Ray: Then we can send a technician to almost anyplace in the nation.

Ted: Kathy — bet you thought I forgot you — what about customer service?

Kathy: Customers get very personal service here. When you call Gateway, you'll be assigned to one customer service representative who will follow your order from start to finish. Your personal rep will make a special effort to get to know you and make sure you're completely satisfied.

Norm: Hey, this sounds almost too good to be true.

Ted: Some people think that. But our customers don't — ask them. They know Gateway 2000 is the best value in the industry.

Norm: Do we have an ad yet?

Ted: Yeah, I think so. All I have to do is cut some prices on our systems. Then get ready for a really hot summer...

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Kathy Skidmore, Customer Service Manager

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NANOBYTES

Trying to give computer makers a way to build more highly integrated and less expensive systems, **Chips & Technologies** (San Jose, CA) has developed a new chip set for implementing a **complete AT compatible on a motherboard**. The Entry-Level Enhanced AT set provides complete system logic, I/O, mass storage, and VGA control in either a three- or four-chip set. Company officials say that a typical 1980s-style AT uses about 95 ICs (excluding RAM). The ELEAT set reduces that number to 44 and cuts the cost of the silicon from $179 to $105, they say. The company plans a 386SX version for the third quarter.

Advanced Data Servers (Boise, ID) claims that its new dBASE Query Accelerator ($1995) **speeds up database queries** by as much as 100 times. The AT-bus board is a SCSI disk drive controller and database coprocessor rolled into one. When the CPU issues a database query to the disk drive, an Advanced Micro Devices RISC chip on the board intercepts the request, processes it, and returns it to the CPU. The RISC chip is optimized for database work and can select and project records faster than a host processor, ADS says.

At the recent Interface show in Dallas, **IBM** showed its version of **TCP/IP for OS/2**. IBM's brand of the standard internetwork protocol will run on top of IBM's Extended Edition of OS/2 1.2 and have an icon-oriented E-mail application.

Market researcher **American Business Information** (Omaha, NE) interprets changes in the marketplace by compiling changes in Yellow Pages listings. Fewer listings for a particular service or industry means business is down in that area, ABI says. According to the researchers' findings for 1989, computer-related categories were down. **Data systems consultants** and **data-processing services** were in the top 20 categories of decline.

without affecting processor performance, Matrox says. Company representatives demonstrated the MP-860 with a Matrox 8514/A-compatible graphics board; a system with a single MP-860 was calculating and drawing 400- by 400-pixel areas of the Mandelbrot set with 2000 iterations per pixel in 2 seconds.

Truevision (Indianapolis, IN) introduced a 33-MHz i860-based graphics processor for IBM AT compatibles. The new Horizon860 "single-card computer" ($6295) incorporates a high-speed bus, called the HorizonBus, that Truevision claims has a peak data transfer rate of 264 MBps. Truevision did not announce any products that are able to take advantage of the bus, but a product engineer said that those will show up later.

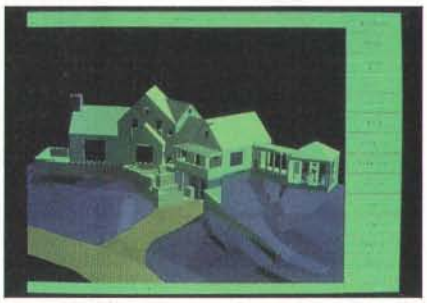
Hyperspeed Technology (San Diego, CA) introduced a board that can support one or two i860s and up to 16 MB of RAM. Like the Horizon860, the Hyperspeed board (which costs about $7000) has a 64-bit high-speed bus but no products that can use it yet. Hyperspeed promises a frame buffer in the near future. Spectre Corp. (Woburn, MA) announced a board that uses single or dual i860s but did not have units on hand to demonstrate.

—Nick Baran, Owen Linderholm, and Tom Yager

NCGA

AutoCAD to Jump Through HOOPS for 3-D

Autodesk will incorporate the HOOPS Graphics System from Ithaca Software (Alameda, CA) into future versions of AutoCAD, the prominent CAD package. HOOPS is an integrated library of software routines that developers can use to create interactive three-dimensional graphics applications. Autodesk will use HOOPS to improve the performance of AutoCAD, in particular when working with solid 3-D models.



AutoCAD image put through HOOPS.

The HOOPS library is written in C and can be called from C or FORTRAN programs. HOOPS is currently available across a wide range of platforms, including extended DOS, OS/2, Mac II, and Unix workstations. HOOPS is completely source code–compatible across all these platforms and automatically works with the window managers associated with each system.

The agreement with Autodesk will help HOOPS become established as a standard set of tools for 3-D imaging, says Gary Wayne, Ithaca's executive vice president.

The boom in graphics display systems based around processors like the Texas Instruments 34020 will mean that within five years, Wayne says, entry-level desktop computers will be able to manipulate 3-D images in real time. HOOPS is an ideal way to create applications for such systems, he claims. The competing PHIGS (Programmer's Hierarchical Interactive Graphics Standard) is not sufficiently compatible across multiple platforms, Wayne says.

—Owen Linderholm

LSI Logic's Chip Set Could Spur SPARC Clones

LSI Logic (Milpitas, CA) says that it will soon ship the first complete chip set for the SPARC architecture pioneered by Sun Microsystems. Availability of a complete chip set for such a workstation could spur the development of SPARC "clones" from other computer manufacturers.

LSI Logic is one of several suppliers of SPARC microprocessors (integer units and FPUs) and provides both the microprocessor and seven application-specific IC chips used in Sun's SPARCStation 1 workstation. But, as LSI Logic's Kim Alfaro points out, "an instruction unit and a floating-point unit do not make a chip set.

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NANOBYTES

A new study by **Frost & Sullivan** (New York) estimates that the total market for **"smart house" automation systems** could reach $2 billion by the year 2000. For this to happen, manufacturers and industry groups will have to agree on standards and make long-term strategic commitments to the market, as was the case in the factory and office networking sectors, the report says. Favorable developments have included the December 1989 draft publication of the CEBus standard by the Electronics Industry Association and the growing role of the Smart House Limited Partnership, a consortium of vendors, utilities, and trade associations.

Good news, **price cuts**: **IBM** buzzed PS/2 prices by anywhere from $300 to $2000; the Model 80-111, for example, fell from $8995 to $6995. **AST Research** reduced retail prices of its 286-based Bravo and Premium computers by as much as 20 percent; for example, a Premium 286 with a 40-MB hard disk drive is now $2395. **E-Machines** lowered prices of its color Mac monitors by as much as $500. And as the market gets more competitive, **NewGen Systems** trimmed prices of its TurboPS PostScript laser printers, which are built around Intel's i960 processor; the TurboPS/300, for example, is down by $1000 to $4495. **NEC Technologies** cut $1000 off the price of its Silentwriter LC890XL PostScript laser printer, which is now $5995. And **QMS** lowered its JetScript PostScript controller for HP's LaserJet II by $300, to $2195.

As **NASA's Hubble Space Telescope** goes where no telescope has gone before, its 600-pound Planetary Camera will be sending back photographs of heavenly bodies. Inside that camera are eight image-sensing chips from **Texas Instruments**. These tiny charge-coupled devices will record the images of such things as stars, planets, and black holes and zap them back to earth for processing.

Apple needs to focus on becoming a "global player" in the 1990s, Spindler said. According to Spindler, who formerly headed Apple's European operations, Apple must evolve from a U.S.-based computer company to a true multinational corporation that designs, manufactures, and markets its products all around the world. Two years ago, he said, his goal was to make Apple's nondomestic sales total between 30 percent and 35 percent of the company's total sales by the end of the 1980s.

"We were absolutely wrong; by this year, the outside business is 45 percent," he said. And in a couple of years, Spindler believes, outside sales will exceed those inside the U.S.

As part of its global efforts, Apple now has a product development laboratory in Paris. Even though the "largest talent pool of the computer industry" is in Apple's Silicon Valley backyard, the company can't assume that all the innovative ideas are here, Spindler said.

—Jeffrey Bertolucci

Telecommunications Act Could Change the World of Electronic Information Services

A U.S. House of Representatives subcommittee has begun hearings on a bill that could drastically change the telecommunications industry by allowing telephone companies to get into electronic information services. The bill, which will be the Telecommunications Policy Act of 1990 if it becomes law, is currently in the Energy and Commerce Committee's subcommittee on telecommunications and finance.

Under the bill as now written, telephone operating companies (e.g., New England Telephone or Mountain Bell) would be allowed to provide information services, including electronic publishing, advanced network services, electronic Yellow Pages, and customer network management services outside their home states. Within their home states, they would be restricted from operating information services other than those already running when the new law goes into effect.

"Electronic publishing" is defined by the proposal as the provision of any information service that the operating company "has, or has caused to be, originated, authored, compiled, collected, or edited" and that is disseminated outside the company by some electronic means.

Some newspaper publishers have opposed the phone companies' getting into electronic information, afraid that they will take away the mainstay of classified ads. Terry Maguire, a spokesperson for the American Newspaper Publishers' Association, said that his group considers the draft a "step forward." But, he added, the ANPA sees "some changes that need to be made" before it could support such a bill. He said a basic problem is that the draft "fails to recognize the basic problem is the telephone company control of the local loop." He said that the solution to this problem is competition at the local-loop level, just as there is now competition at the long-distance level.

"We support . . . the provision of electronic telephone directories," he said, "but we believe no case has been made for why the telephone companies need to control information [other than telephone number listings]."

The FCC "cautiously" supports the proposal, said a subcommittee press aide.

Capitol Hill insiders and telecommunications-industry watchers give the bill little chance of passage this session but consider it a good indicator of the mood of Congress.

—George Bond

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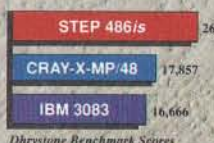

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Circle 115 on Reader Service Card

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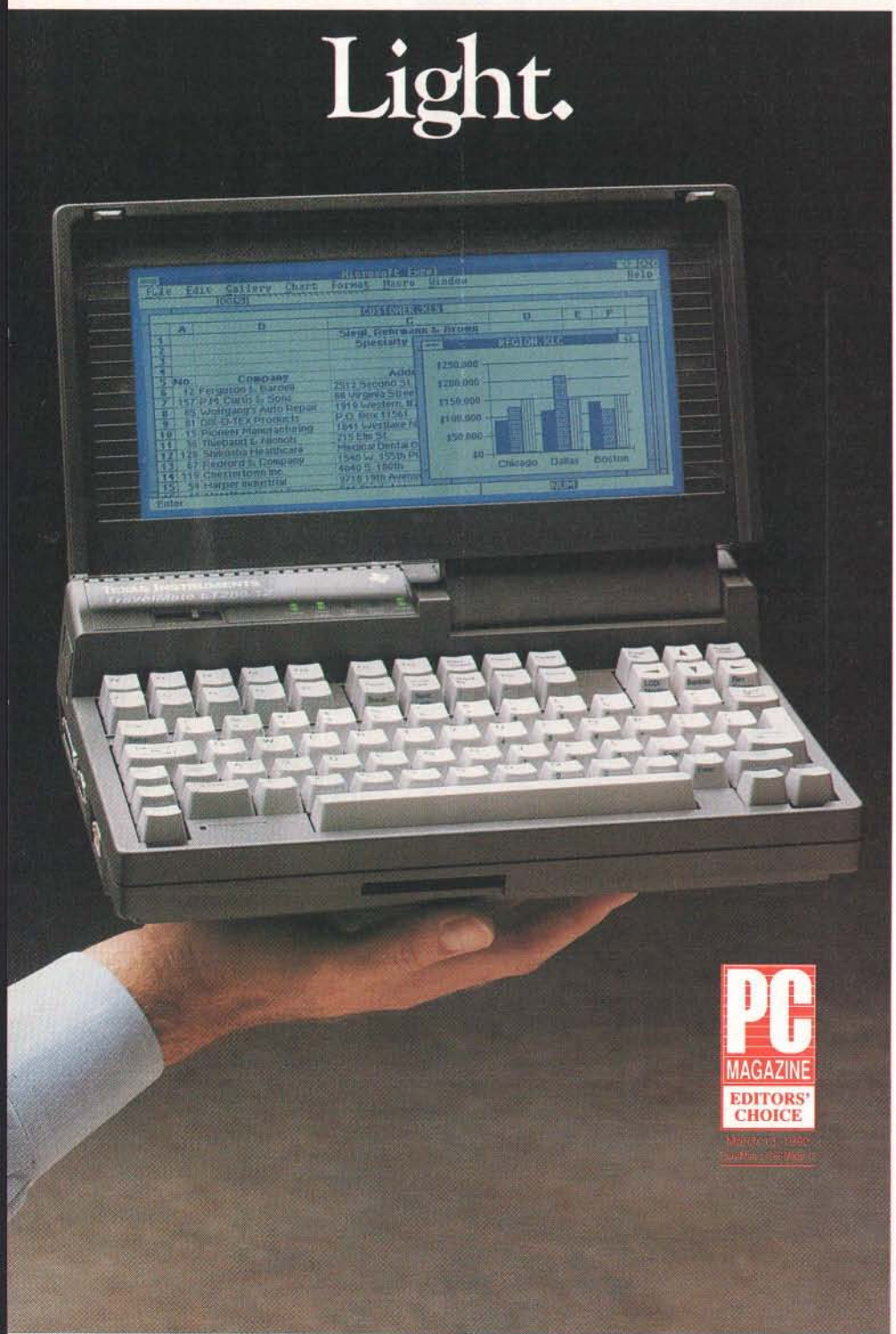

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LETTERS

and Ask BYTE

Micro Craft Dimension Remembered

Kenneth M. Sheldon's article "Micro Edsels" (February) mentioned the Micro Craft Dimension, of which hardly anyone has heard. The reason for this probably lies in the letter to Micro Craft from BYTE telling the company that its full-page color ad brought greater response on the reader service than any other ad. The story is far more interesting as an experience in modern company funding and lack of focus. For instance, all those reader service cards ended up in a closet and were not used.

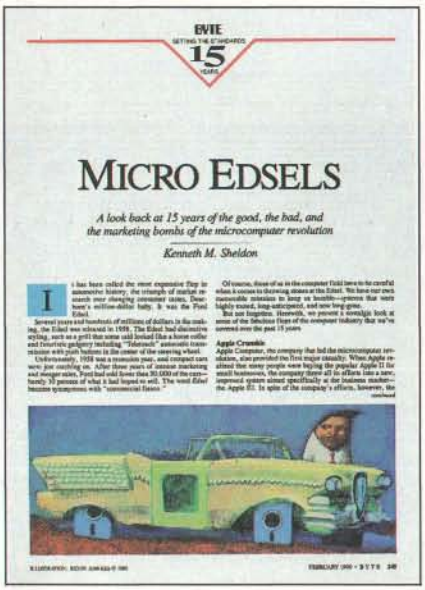
I have a Dimension in my garage. It has the Z80, 8086, and 6512 coprocessors. I have it because the company had no cash to pay me for programming the Apple "slot 7" interface to CP/M-68 disks. I used it as my only MS-DOS machine for several years.

Sheldon said that it "would supposedly run Apple, IBM PC, TRS-80, CP/M, *and* Unix programs. . . . It didn't." It did. It did not run *all* the software for all those machines. But what it did run, it ran well.

Originally, the machine was designed to be an OEM fast replacement for the Apple in a specific color graphics application, while including the ability to add coprocessors. PC capability was added early. The OEM base income was abandoned when funding was obtained from a company in the long-distance market. This company pushed for selling it retail and for the color ads. Little distribution work was done. Too much money was spent on good-looking offices for the wrong people.

The Dimension's problems were complex. The IBM PC coprocessor worked well until programmers began using scan codes rather than the ASCII codes. The designer chose an ASCII keyboard, so hot-key combinations such as Control-Shift never reached the computer.

The Apple II emulation worked well as long as you stayed with II Plus or were careful with IIe emulation. But for some odd reason, the programmer for the 80-column card created neither a pure IIe card nor a pure old-style card. The machine read Apple II disks on standard drives with special interface lines on the expansion bus; an eerie thing about using the Dimension was being able to move data from a CP/M-68 disk to an Apple disk or vice versa using one drive.


BYTE
15
YEARS

MICRO EDSELS

A look back at 15 years of the good, the bad, and the marketing bombs of the microcomputer revolution

Kenneth M. Sheldon

The CP/M Kaypro emulation worked flawlessly. Of course, the people who wanted to run Apple CP/M disks were out of luck, even though everything they needed was sitting right there in the box. My experience with Micro Craft poisoned me for combo machines.

Mike Firth
Dallas, TX

Thanks for filling in some of the details for us, Mike. Your comments that "the Apple II emulation worked well as long as. . . " and "the IBM PC coprocessor worked well until. . . " are indicative of the Dimension's problem. While it may have run some Apple, IBM PC, TRS-80, CP/M, and Unix programs, it certainly didn't run all of those, as the ads implied. As I said in the conclusion to the article, many of the machines mentioned were sunk by circumstances or poor marketing—no fault of the designers. The Dimension may have been one of those.

—K. S.

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Your letter will be read, but because of the large volume of mail we receive, we cannot guarantee publication. We also reserve the right to edit letters. It takes about four months from the time we receive a letter until we publish it.

Mac XL No Edsel

I thoroughly enjoyed "Micro Edsels." Kenneth M. Sheldon writes that Apple's tactic of renaming the Lisa as the Macintosh XL and dropping its price didn't work. In fact, it worked all too well.

Apple's strategy was to provide an interim hard disk drive–based machine for the Macintosh Office until the Mac itself could be reengineered to serve in this capacity. Based on the Lisa's sales history, Apple believed that it had enough parts on hand to shut down Lisa parts production. To the company's surprise, sales took off so dramatically that the product was canceled after only a few months due to a lack of parts, not lack of demand. Had parts production not been canceled, the Lisa/Mac XL might not today be considered one of the industry's Edsels.

Tom Eisenmenger
Winston-Salem, NC

The "Father of ASCII" Speaks

Rip Collins suggested in the January Stop Bit that many aspects of ASCII made it unsuitable for the brave new PC world, as opposed to those old fuddy-duddy mainframes. 'Tain't so, folks.

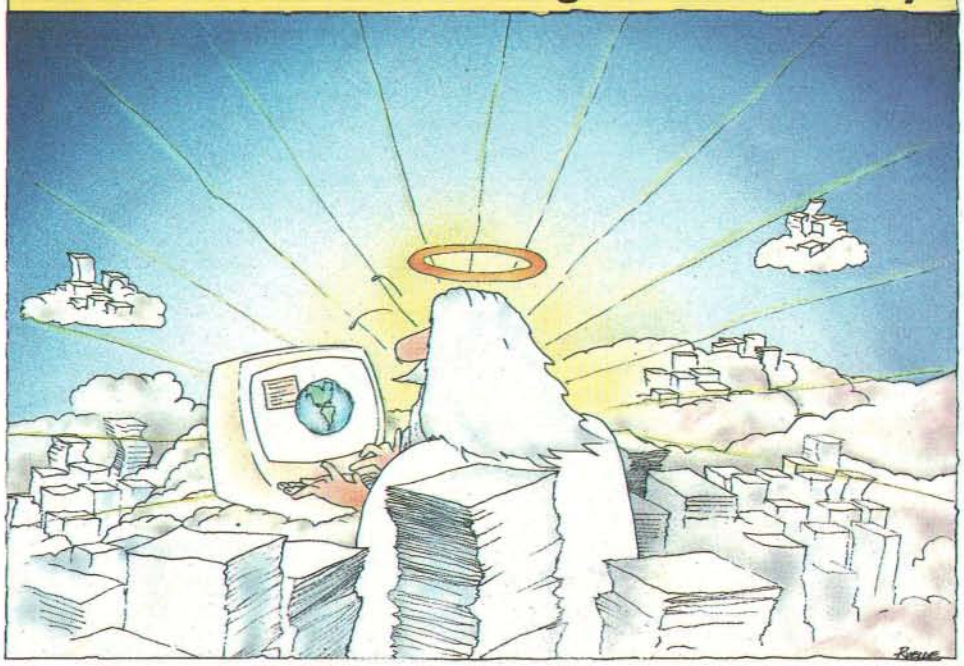
First, let me correct the impression given by Collins that I created ASCII. It is true that my license plate says "ASCII" and that the frame says "Yes, I am the father of ASCII." It gets some laughs. I did contribute six characters to ASCII, most importantly Escape and the backslash. I did as much as anyone to promote a single, common interior and exterior character set for computers. One of the early versions of ASCII was called Bemer-Ross Code (mostly in Europe). Finally, I have written the bulk of the public articles on ASCII.

But it is not correct to say that I created ASCII. To say this insults many people who dedicated years of their lives working out compromises between dozens of existing codes for the resultant single code. I have never demurred at being called the "father of ASCII," as it is the "mother" who creates.

Also wrong is the statement that

continued

Great Moments in C-Programmer History



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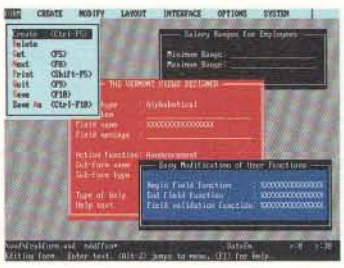

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ASCII was created in 1965. Some of its origins were at IBM in 1959, and the nationwide effort began with the ANSI X3 committee in 1961, leading to approval in 1963. President Johnson's order in 1964 made it the first federal Information Systems standard.

With the history straightened out, I'll try to remedy Collins's complaints. He started off with collating (ordering) sequence, showing that you cannot order a file very well by using the binary sequences for character representation. Of course you can't! The New York Telephone Company, if asked, might send you its multipage set of rules for ordering the names in telephone directories. To think that characters should be grouped in a set by their usage (e.g., all arithmetic operators) is as futile as thinking that all vowels should lie next to each other on a keyboard, or that keys should be laid out in alphabetical order. No way!

Why else did IBM buffer the key-to-CPU interface with scan codes, if not for myriad variations in usage, including national languages? ASCII, being worldwide, must serve those different languages, not all of which define the ordering sequence the same.

Next, Collins takes compound delimiters to task, not for being composed of two characters, apparently, but because the designers and standardizers of the various computer languages cannot agree. Blame them, not ASCII. I proposed in 1962 that the character sets of several programming languages each be assigned a unique escape sequence for identification. Then you type that sequence to commence the program, and your compiler knows what each combination means. Just like scan codes, hey?

Enough. There is a registry book for code sets, each set of which has its own unique escape sequence to identify it (I'll take a little credit for that, too). The Japanese 8- and 16-bit sets of TRON are registered there. So are videotext, computer graphics, Arabic, Chinese, bibliographic controls, astrology symbols—you name it. And, of course, PCs, contrary to mainframes, reach to the bit and pixel, allowing creation of single graphics for any discrete character (so the compound delimiters can disappear).

Finally, ASCII has been set up to be marvelously flexible, through both extension (i.e., alternate sets defined by escape sequences) and expansion (i.e., larger sets, 8 bits and up, also via escape sequences). The scope that I drafted for X3 in 1961 was to develop "a single standard for logical representation of characters and character format in the media used for interchange of instruction, data, and control information between data processing equipment, together with orderly provision for expansion and alternatives."

I say that we met our goal. ASCII is now embedded in billions of dollars' worth of equipment—so much so that I don't believe that people will spend that much money to replace it. If anyone really finds something that ASCII needs, address the standards bodies formally, not the casual user informally.

R. W. Bemer
Phoenix, AZ

Systemantics Author Responds

As the author of *Systemantics*, I was delighted to find my book reviewed in Hugh Kenner's Print Queue column (January). However, the review failed to specify where *Systemantics* can be obtained. The address is: General Systemantics Press, 3200 West Liberty, Suite A, Ann Arbor, MI 48103. The price is $17.95 paperback, $21.95 casebound.

Readers' initial responses to *Systemantics* tend to be either strongly positive or strongly negative. A typical positive response is along the lines of: "Yes! Yes! This is what happens to me all the time! Thank goodness someone has finally brought it out into the open!"

Negative responses tend to be like this: "Why does this guy keep harping on the bad stuff? So mistakes happen. Is this any reason to dwell on them?" Negative responses are more interesting than positive ones because they indicate that learning could be about to take place.

Just before a dolphin actually gets to the point of a new routine, it gets more and more irritable, swims in circles, and finally loses its temper, leaping out of the water and splashing its trainer. Psychologists call this "cognitive dissonance"—that irritating feeling that something just doesn't fit. Karen Pryor, the Dolphin Lady, whose animal-training methods are used worldwide, calls it the "learning tantrum."

Down through history, the learning tantrum recurs at moments of crisis. When Darwin proposed his new theory, the Establishment had a collective fit. Sigmund Freud had to set up his own press in order to get published. And the new breed of scientists around Einstein recognized sadly that new theories in physics prevail only as the previous generation of physicists dies off.

The realization that human beings operate cybernetically—that is, by feedback and error correction—is a major advance. Gregory Bateson once called it "the biggest bite out of the apple since Eve."

It is also a difficult idea to grasp. But error correction is what we do. We *notice the difference* between our expectations and our actual sensory feedback. When we notice it, we register it as an error, a defect, a failure, a shortcoming—something to be corrected. If, instead of recognizing the discrepancy, we try to shut it out and proceed as if it weren't there, then we have the bizarre, funny, sometimes excruciating results cataloged in *Systemantics*.

Anyone who struggles to take in this hard and humbling lesson—that error is our existential situation and that our successes are destined to be temporary and partial—deserves our sympathy. *Systemantics* is an attempt to make the experience bearable by means of humor and irony. Those are the qualities that people have called upon through the ages to enable them to cope with the permanently provisional human situation.

I'm glad that Kenner found *Systemantics* disturbing, because there is, after all, a deeper, more serious side to it under the humor. There really are unknown and perhaps unknowable aspects of the world around us, and awareness of that fact is a very necessary part of any significant approach to human knowledge. Kenner may be right in suggesting that there are "demons" in *Systemantics*. But they were not put there by John Gall. They reside in the material itself—or perhaps they are projected there from the mind of the observer?

John Gall
Ann Arbor, MI

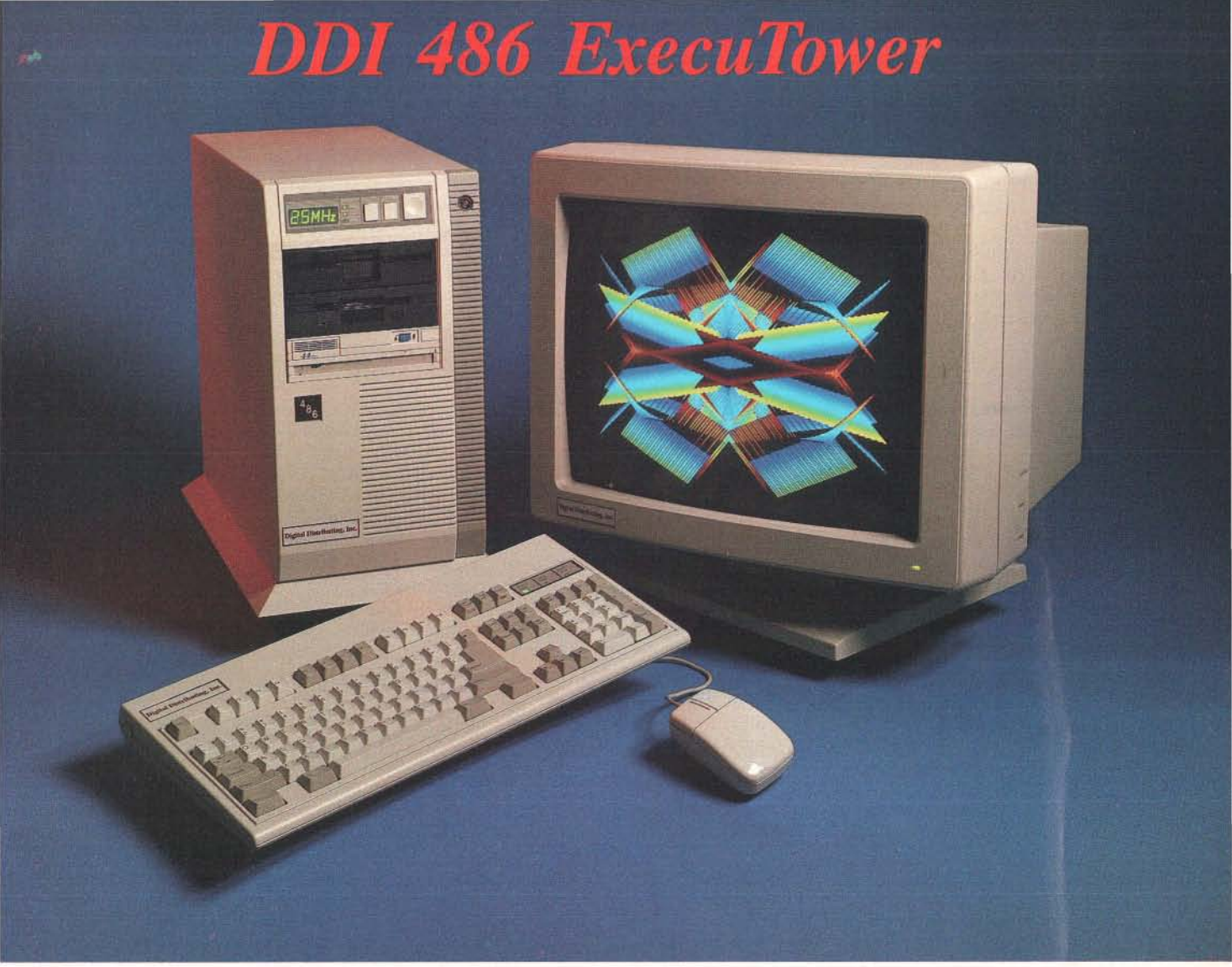
"Mistakes happen." Sure. Murphy said so. An instance is Gall's misrepresentation of Murphy. Mistakes are not cosmic flaws; it's humans who are error-prone (although amid the titters it's not easy to be sure what he's saying). I'll go on affirming that he's drawing laughs by letting us confuse human with cosmic flaws. He's found a good racket. Erma Bombeck has worked it for years at the best-seller level; cf. her famous claim that washer-dryers eat socks.—H. K.

February Was a Good Month

The February BYTE was for me a strong winner. I was perusing the 1989 annual index to see if any topics looked interesting, and, sure enough, I ran across "Modems" and "Protocols." I whipped out the appropriate copies of BYTE and flipped right to the information for which I was looking. Excellent!

continued

DDI 486 ExecuTower



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Circle 86 on Reader Service Card (DEALERS: 87)

David Fiedler's Unix /bin column, "Dealing with Devices," also had information that I can use. I have limited access to a Unix machine, and Unix /bin will be especially useful in making the most of that time.

I had recently considered allowing my subscription to lapse because I thought that BYTE wasn't particularly useful with the machines I work on. This issue has totally destroyed that misconception. Great magazine!

Richard E. Lafleur
Rochester, NY

Ray Tracing, Micro Style

Owen F. Ransen's article, "The Art of Ray Tracing" (February), was informative and thorough, but very misleading. It concentrated solely on ray tracing done by Inmos transputer-equipped machines, paying only passing tribute to popular microcomputers. Contrary to the statement that ray tracing on microcomputers tends to take hours per image, many images can be produced in a matter of minutes.

Ray tracing has been popular on the Commodore Amiga since its introduction, and more recently on the color Macintoshes. The faster Amigas with 16- or 25-MHz 68020s and 68030s with equivalent math coprocessors can render complex images in mere minutes. Images produced on these machines are no less spectacular than those produced using the Inmos transputers.

At least a half-dozen commercial and public domain ray-tracing programs are available for the Amiga, and at least one for the Mac. Both these systems are cheaper and more widespread than the Inmos T800 machines, making ray-traced quality available to the general public.

Charles E. Hill
Orlando, FL

ASK BYTE

Not Enough Ports

How can I access more than two communications ports on an IBM PC? Procomm uses ports COM1, 2, 3 or 4. Can a mouse be configured to work with COM3 or COM4? It seems that using modems and a mouse and connecting to a host all require more and more communications ports—and there are only two available in the DOS environment.

Stefaan Dupont
Menen, Belgium

Because of the limitations of PC-DOS and the PC BIOS, you are limited to just two communications ports. Certain versions of MS-DOS can handle four communications ports. However, these four communications ports still use the two interrupt request lines: Int3 and Int4.

Most mouse software is configured to use COM2. Of all the mice I've checked (Logitech, Key Tronic, and Microsoft), all use COM1 or COM2.

My only suggestion to you is to use a serial switch box if you have more peripherals than ports.—S. W.

No Warm Boot

My 20-megabyte Seagate hard disk drive won't successfully do a warm reboot anymore, even if I try it soon after I start it up. I'm no power user, so I can't determine whether it's a software or hardware problem. I wrote to a number of companies that produce hard disk utilities, but I got no guarantees. So before I shell out some money for a hard disk repair package, is there any help you can give me?

Joseph A. Bligh
Lakewood, CA

If I read your note correctly, it implies that your hard disk drive does execute a cold boot (i.e., when you power the machine up) properly. This leads me to suspect your hard disk drive controller card. Either the BIOS ROM on the card has gotten corrupted, or whatever circuitry that reads the RESET line has gone south.

Your first repair attempt should be to reseat any socketed chips on the card and your motherboard (be very careful!). If that fails, try locating someone with a similar controller card, swapping it for yours, and seeing if the problem follows the card.—R. G.

Switching Fax

In your December 1989 Ask BYTE, one of your readers inquired about devices for switching telephone lines between phone, fax, and modem. I would like to inform your readers that we have designed and are marketing a complete line of such devices. Interested readers should contact TSX Products Corp. (450 Washington St., Suite 103, Dedham, MA 02026, (800) 879-7706 or (617) 329-1779.

David A. Vogel
Dedham, MA

Thanks.—BYTE Lab Staff

Shopping for Print Shop

At our office, we recently purchased Broderbund Software's Print Shop and Print Shop Companion.

On our first purchase we acquired the 5¼-inch floppy disk and attempted—unsuccessfully—to install the software from a Sysgen external 5¼-inch floppy disk drive onto our IBM PS/2 Model 50. After losing one of our four shots available on the Print Shop package, we contacted Broderbund's technical-support people and were informed that it was not possible to load from a B drive. They suggested that we wait until a non-copy-protected version of the software was available.

Having learned our lesson, on our second purchase we procured 3½-inch floppy disks. After a successful installation onto the same Model 50, we tried the Print Shop Companion. After the first attempt, for unknown reasons we had only two installations left, as opposed to the three we should have had.

Everything appeared to be working rather well—until we tried printing a calendar on the Hewlett-Packard LaserJet 500+ printer. (We followed all instructions to a T before finally despairing and calling for help.) One telephone call to Broderbund confirmed our worst suspicions—that although the Special Printer Set-Up instructions list the HP LaserJet Series and compatibles, it could not run successfully on our LaserJet 500+ printer.

Perhaps we read too much into the phrase "and compatibles." In any case, is there anything we can do to make this software package run smoothly on our equipment? We now have two copies of what could be some very useful software, but we can't use it where we would like to.

Pam Gray
Terri Baston
Internal Revenue Service
Cincinnati, OH

Your installation problem is one of the many reasons that the marketplace has overwhelmingly rejected copy protection. In spite of what the copy-protection industry may tell you, legitimate owners are frequently inconvenienced by these schemes.

I called Broderbund and asked about the LaserJet 500+ compatibility. Apparently, the LaserJet support is for Series II–compatible printers only, not the original series. There's nothing you can do to fix either the software or your printer. You might try calling the company's customer service department at (800) 521-6263. It sounds as though the people there are more than willing to help you

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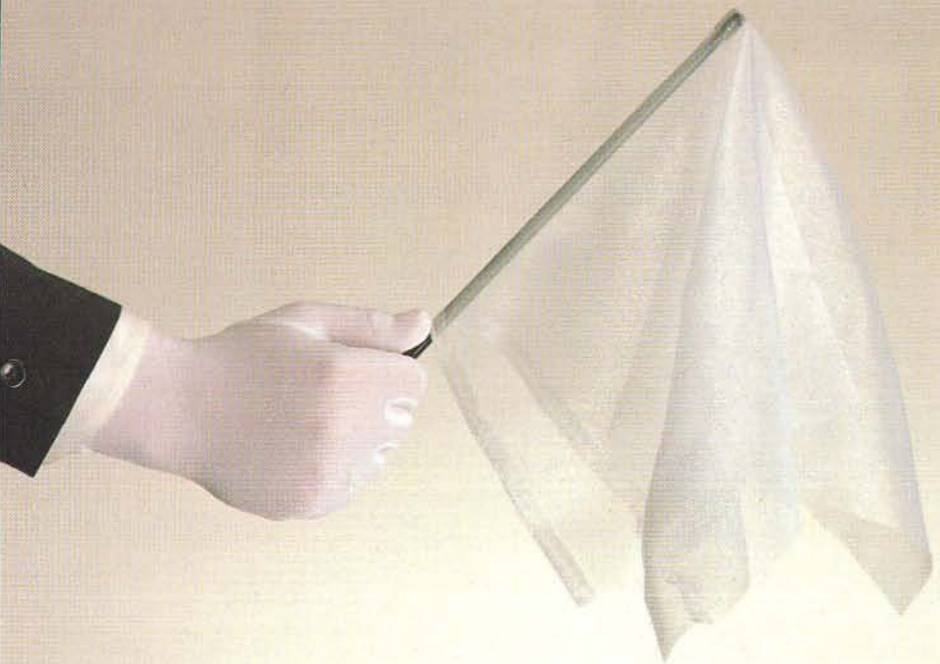

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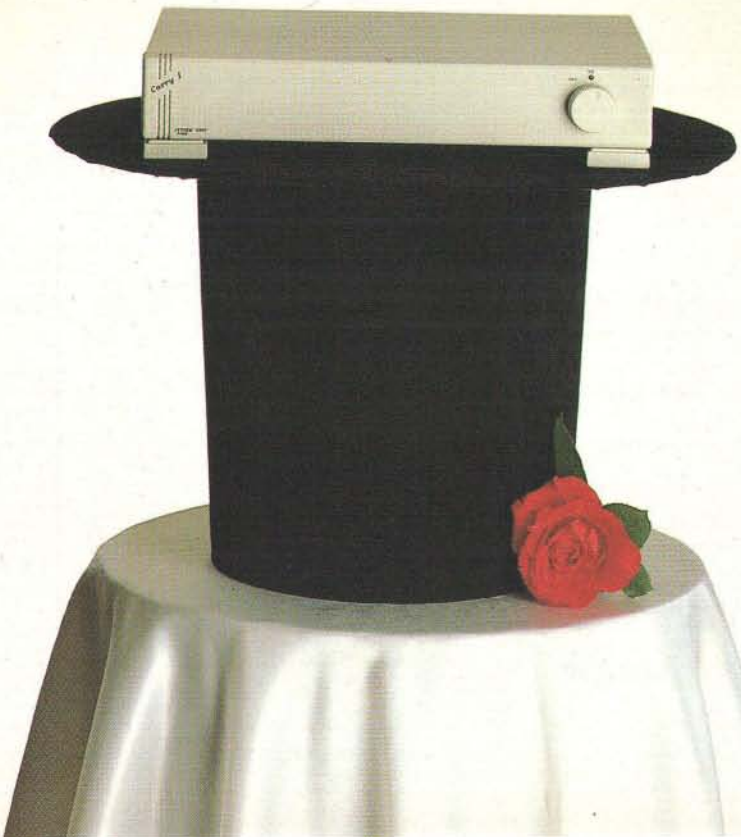

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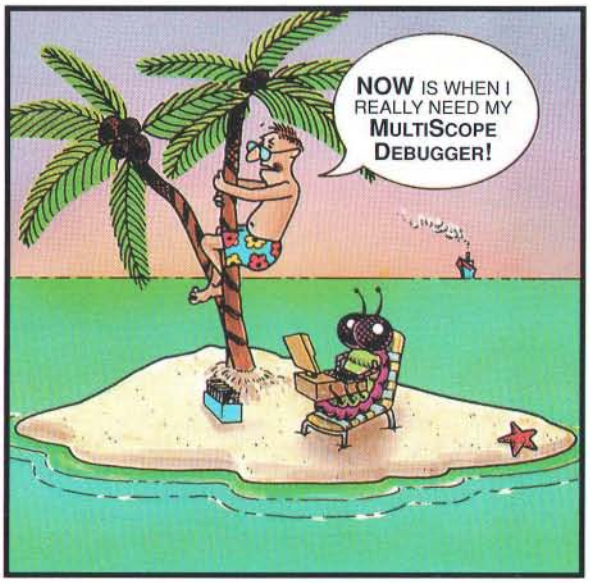

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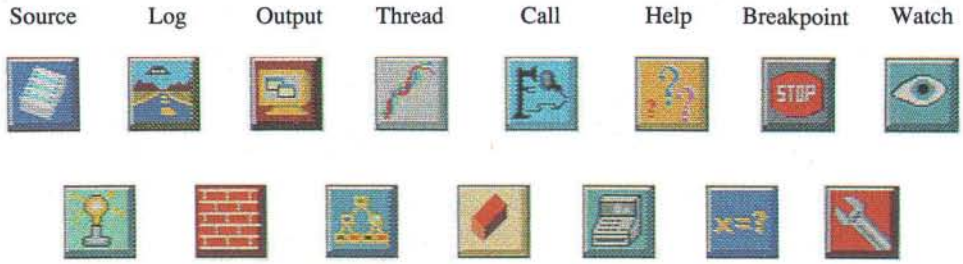

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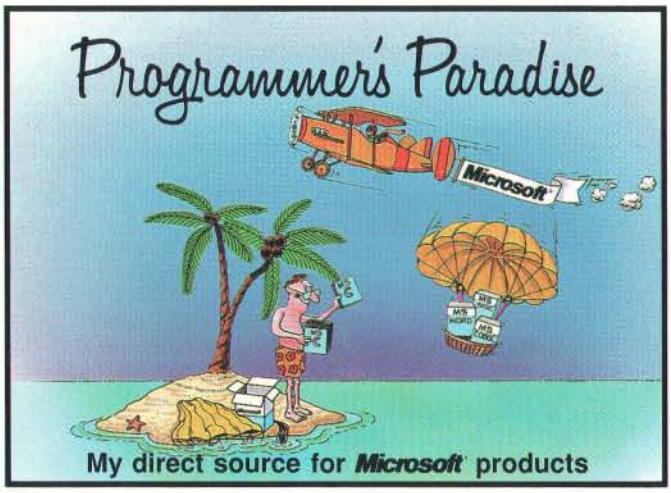

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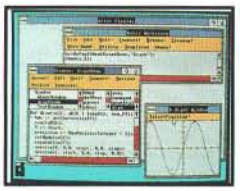

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out. Maybe if you promised not to audit them?

In any case, you're not stuck. You could always sell the LaserJet 500+ and buy a new printer, or sell your copies of Print Shop and look at some other software. Print Shop is a nice package, and you shouldn't have any trouble finding someone to take it off your hands.

—H. E.

The Limiting Factor

I have a Tandy 1000 TX with two 3½-inch floppy disk drives, a 286 processor, a 32-MB hard disk drive card, a 2400-bps modem, a mouse, and 640K bytes of RAM (expandable to 768K bytes on the motherboard). I am using two of my 10-inch expansion slots, which leaves me three slots not in use. The question is, can I add memory boards? Can I add an external drive? Is my power supply the main limitation to my expansion capabilities? If so, does anyone produce a power supply unit that will fit into my computer?

One problem that I have occurs when I use PC SHELL from memory-resident PCTools 5.5: I find myself out of memory. I usually use WordPerfect 5.0 and Reflex 2.0. I have problems with anything that requires 640K bytes (and some programs that require 512K bytes). I plan on expanding to 768K bytes as soon as I can get the chips, but I would like to expand past that point.

L. David Morris
Milan, TN

You're absolutely right: Your power supply is a serious limitation. The 1000 TX came standard with a miniature 67-watt power supply. Tandy does not support an upgraded power supply for that model; in fact, the company seems to frown on the very idea. Most Tandy Computer Centers don't suggest a second hard card for the 1000 TX for fear of blowing the power supply.

Your troubles are compounded by the small physical size of your present unit. Perhaps the people at PC Power and Cooling could help you (31510 Mountain Way, Bonsall, CA 92003, (619) 723-9513). They specialize in power supplies. I found a 200-W supply with petite dimensions (5⁹⁄₁₀ by 5½ by 3⅖ inches) and standard motherboard connections, but I'm not sure of the exact size you require. Measure your power supply and give PC Power and Cooling a call.

That's not your only limitation, however. The 1000 TX is a bit of a hybrid. Although it sports a 286 processor, it runs on an 8-bit bus, so it is really an XT-compatible model. Also, as you mention, it will not take full-length cards. I looked through a JDR Microdevices catalog and found some memory-expansion boards and disk drive controller cards that would fit in your computer, but a technician at JDR told me that Tandy compatibility is a hit-or-miss proposition. Fortunately, JDR has a 30-day money-back guarantee. I suggest ordering the card you want, testing it in the 1000 TX, and returning it if you have any problems. To order a catalog from JDR Microdevices, call (800) 538-5001.

Intel has no memory-expansion cards less than 10 inches long. AST Research does, but a technician there also warned me about Tandy's hardware incompatibility. Tandy machines run PC software without a problem, but the hardware does not strictly follow IBM specifications. The AST technician suggested that I stick with Tandy products.

Tandy does offer some solutions. The company sells an expanded memory board specifically for the 1000 line. For reasons only Tandy would know, the folks there call it the Micro-Mini Mainframe. They also sell a 20-MB hard disk drive card for the 1000 TX that supports a second external hard disk drive. The external drive should house its own power supply. If your hard disk drive card is not the standard Tandy model, call the vendor who sold you the card and ask if it supports a second external drive.

I suggest that you work around your memory limitations. There's no reason why you shouldn't be able to run WordPerfect and Reflex with the hardware you now own. First of all, I would avoid memory-resident software. You should run PC Shell from the command line, not as a TSR program. The only thing you lose is hot-key access to the program and the ability to cut and paste to the clipboard from external applications. That is a small price. Any time that you need your PCTools utilities, you can just type in `pcshell` *for PC Shell or* `desktop` *for PC Desktop. You can also add the* `pcshell` *command to the end of your AUTOEXEC file so your computer will load PC Shell each time you turn on your computer.*

I would not run your application programs from the PC Shell user-defined menu, either. You would still have the shell stealing precious RAM. Instead, simply exit from the shell and fire up your application. It should run within 640K bytes without any hassle. If you really must run PCTools in resident mode, use the /RTINY switch (shell/RT) to cut the kernel size down to 9K bytes or so. The program will take a bit more time to activate, but you'll have more memory for those hungry applications.

For more tips on working within the 640K-byte memory barrier, see the In Depth section of the March BYTE—Life Within 1 Megabyte. If you acquire expanded memory and insist on running resident software, you should get a copy of PopDrop Plus or another utility that keeps your TSR programs organized.

—S. D.

Manual Labor

I have purchased a used TEC serial printer whose model number is F10-40. I am looking for a source to find an owner's manual or a photocopy of one. My local computer store can't help me. Can you?

Dave Grunewaldt
Eau Claire, WI

I'm a little confused. The model number that you mention is a C. Itoh printer, manufactured by TEC. If that's true, the printer should say "C. Itoh" on it somewhere.

Assuming that you in fact have a C. Itoh printer, owner's manuals are available directly from the company by calling (800) 347-2484 and asking for Customer Service at ext. 6105.—H. E.

FIXES

- The correct price for Lotus Manuscript, mentioned in Wayne Rash Jr.'s Down to Business column (January), is $495. Also, WordPerfect has a screen capture utility called Grab.
- The proper reference to the Super VHS connection in Phillip Robinson's "The Four Multimedia Gospels" (February) should have been "Y/C," rather than yellow/cyan. The Y/C refers to the separation of the Y (luminance) and C (chrominance) signals.
- The contact point for the Interlink network mentioned in "State of the BBS Nation" (January) is Andy Keeves's Executive Network BBS, the international host for InterLink, which can be reached at (914) 667-4567.
- Regarding the January Short Take on the Opus Portable Mainframe, the correct maximum data transfer rate for the AT bus is 6 megabytes per second.
- Novell does offer upgrade options to NetWare 386 ("NetWare 386: Less Pain, Great Gain," March). Prices range from $2495 to $7580, depending on the version of NetWare you want to upgrade. ■

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Dell's 320LX is one of the first 386SX systems with a 20-MHz clock speed.

Dell Introduces a Faster SX in a Large Chassis

Dell's 20-MHz 386SX-based system includes 1 MB of RAM, a 40-MB 28-ms hard disk drive, and a monochrome VGA monitor.

The motherboard features room for up to 8 MB, embedded floppy and hard disk drive controllers, embedded I/O with one parallel and two serial ports, and a socket for the new 20-MHz 80387SX math coprocessor.

Price: $2899.
Contact: Dell Computer Corp., 9505 Arboretum Blvd., Austin, TX 78759, (512) 338-4400.
Inquiry 1121.

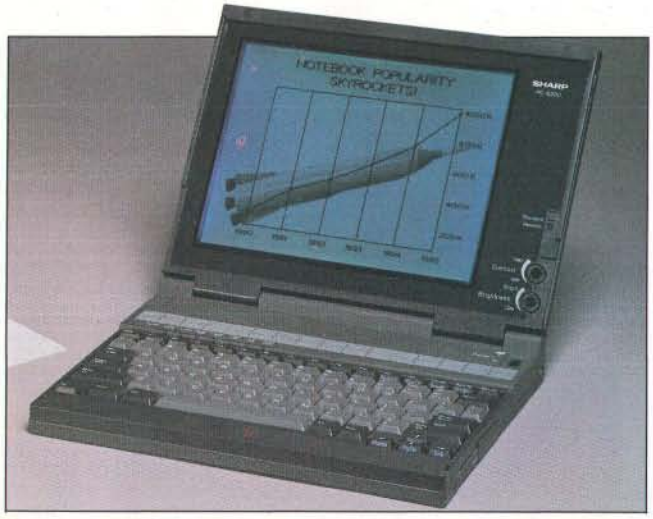
Low-Priced Unix Workstation Features i486

Standard features of the PWS/425C, a short-tower Unix system, include 4 MB of RAM (expandable to 16 MB), a 105-MB SCSI hard disk drive, and a 16-inch color monitor with 1024- by 768-pixel resolution. Also included are a 101-key keyboard, a mouse, a 16-bit Ethernet controller and TCP/IP support, and your choice of a 3½- or 5¼-inch high-capacity floppy disk drive.

The motherboard has one parallel and two serial ports, a socket for a Weitek WTL4167 math coprocessor, and slots for two 16-bit add-in cards. Bundled with the PWS/425C are Interactive Systems' Unix V 3.2 and version 11.3 of the X Window System.

The PWS/425C measures 8 by 12 by 16 inches. An optional 9- by 18- by 24-inch full-tower version has room for eight half-height 5¼-inch disk drives.

Price: $9995; with eight-bay tower, $10,490.
Contact: Mobius Computer Corp., 1717 Embarcadero Rd., Palo Alto, CA 94303, (800) 662-4871 or (415) 493-7777.
Inquiry 1120.



Sharp's PC-6220 is a lightweight and low-cost notebook AT that comes complete with VGA graphics and a 2-hour battery.

Sharp's Notebook Computer Has VGA Screen

The Sharp PC-6220 is a notebook-size 12-MHz 286 machine that features a backlit LCD screen.

It has a footprint the size of a standard piece of paper (8½ by 11 inches), and it's only 1⅗ inches thick. The system weighs 4 pounds, including an internal nickel-cadmium battery that will last for 2 hours.

The 20-MB 23-ms hard disk drive is internal, and you can upgrade standard memory from 1 to 3 MB. The 10-inch screen features Sharp's "triple supertwist" LCD technology to give high contrast.

An optional expansion unit has room for AT-compatible add-in cards and a 3½-inch 1.44-MB floppy disk drive.

Price: Under $4000.
Contact: Sharp Electronics Corp., Sharp Plaza, Mahwah, NJ 07430, (201) 529-8974.
Inquiry 1122.

Arches Come in Two Shapes

Arche Technologies has introduced two inexpensive 25-MHz 386 systems: the Rival 386-25 desktop system and the Pro-File 386-25 tower system.

Both systems include 1 MB of RAM (expandable to 8 MB on the motherboard), a 5¼-inch 1.2-MB floppy disk drive, a controller that supports two floppy and two hard disk drives, a 101-key keyboard, an I/O card with two serial and two parallel ports, a 200- or 275-W power supply, and Arche's own BIOS.

The Rival desktop system, which measures 16½ by 17 by 6 inches and weighs 28 pounds, can house two additional disk drives (one internal). It also can hold one additional 8-bit card and five additional 16-bit cards.

The Pro-File tower system, with the more powerful 275-W power supply, measures 24 by 5½ by 19½ inches and weighs 52 pounds.

Price: Rival 386-25, $2655; Pro-File 386-25, $2955.
Contact: Arche Technologies, Inc., 48881 Kato Rd., Fremont, CA 94539, (800) 422-4674 or (415) 623-8100.
Inquiry 1123.

Color Your Projected Images

The Proxima Data Display VersaColor is a full-color LCD projection panel with its own microprocessor. It is capable of displaying 512 simultaneous colors from a VGA format or from your Macintosh.

The panel makes colors by using three separate LCD panels, one each for red, yellow, and blue. Each panel can display several levels of color using proprietary coloring techniques.

The panel has a maximum resolution of 720 by 480 pixels and provides VGA compatibility in text and graphics modes and high-resolution compatibility with the Macintosh in 640- by 480-pixel modes. For faster displays of simple graphics and text, the panel can be toggled to an eight-color binary mode.

The panel measures 12½ by 12 by 1⅞ inches and weighs 6 pounds. It has controls (some of which are programmable) for things like positioning the display and altering tint. You can also control the panel with an infrared remote-control device.

Price: $6499.

Contact: Computer Accessories Corp., 6610 Nancy Ridge Dr., San Diego, CA 92121, (619) 457-5500.

Inquiry 1130.

Proxima's overhead projection panel displays color from your PC or Mac.

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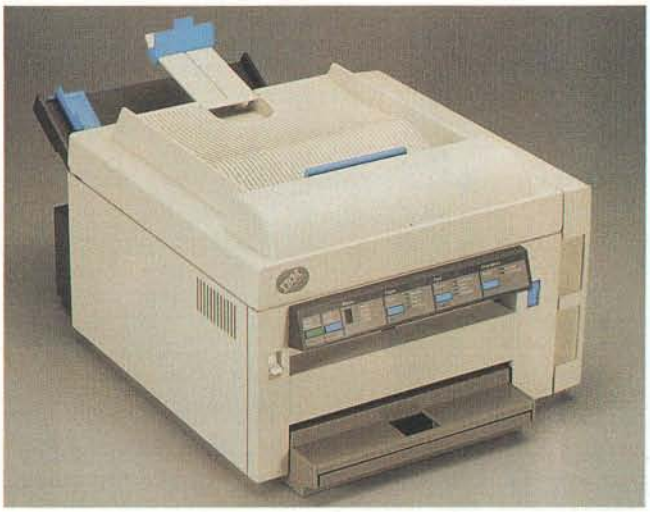


IBM's $1495 Laser Printer E is PostScript-capable.

IBM Targets LaserJet IIP with New $1495 Laser Printer

The Laser Printer E, which prints at 5 ppm, is much like the 10-ppm printer that IBM introduced last fall. Both feature five portrait fonts, five landscape fonts, and an optional PostScript module.

Standard equipment includes a 200-sheet paper tray and 512K bytes of RAM (expandable to 3.5 MB).

The user-installable PostScript module includes 17 resident outline fonts. Another option lets you serially connect up to six personal computers. Upgrading the new model to a 10-ppm system involves replacing the printer's motherboard.

Price: $1495; PostScript module, $499; 10-ppm motherboard, $1099.

Contact: IBM Corp., National Distribution Division, One Paragon Dr., Montvale, NJ 07645, (800) 426-2468.

Inquiry 1131.

NEC Introduces New CD-ROM Drives

Two SCSI-based CD-ROM readers called the Intersect CDR-72 and CDR-82 are external and internal (respectively) 5¼-inch units that read multiple formats of 650-MB CD-ROM cartridges.

NEC says that the readers support IBM High Sierra, Apple Macintosh HFS, and ISO 9660 formats. They're also compatible with Apple's HyperCard.

Data transfer rates are 150K bytes per second in continuous-read mode and 1.5 MB per second in burst mode. Typical seek time is 350 ms. The external model measures 9¼ by 2¼ by 9¾ inches and weighs 7¾ pounds. Interfaces are optional.

Price: Intersect CDR-72, $999; Intersect CDR-82, $899; XT/AT interface, $249; PS/2 interface, $299; Mac interface, $99; ProSpeed LTX interface, $199.

Contact: NEC Technologies, Inc., 1255 Michael Dr., Wood Dale, IL 60191, (708) 860-9500.

Inquiry 1127.

continued

DR DOS on a Plug-In Card for Diskless Boot-Up

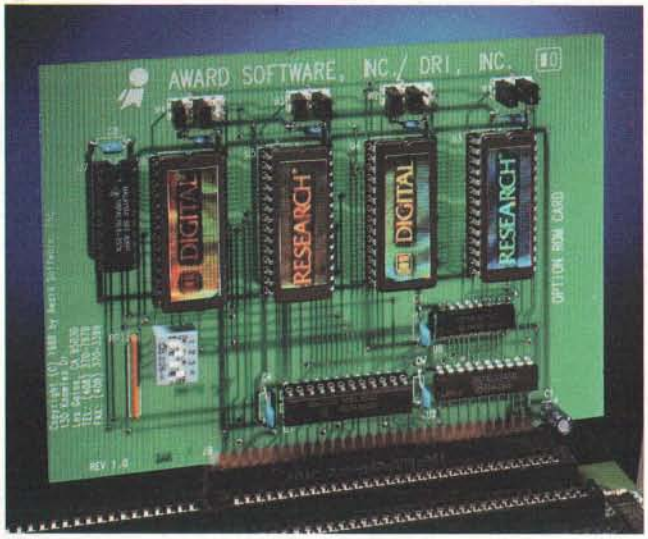
The ROS (ROMed Operating System) 8-bit plug-in card for IBM PC compatibles lets you boot Digital Research's DR DOS operating system without a disk drive.

Until now, Award Software has offered DR DOS in silicon or as software modules of object code. DR DOS is a version of MS-DOS developed to be put in ROM and used in laptops and other systems. It offers all the standard features of MS-DOS plus capabilities added by Digital Research.

Award Software says that booting from the new half-length ROS Card saves your hard disk drive about 41K bytes of RAM. ROS comes with 256K bytes of RAM, which includes the operating system and bundled software utilities. The company also says that ROS removes some of the problems of booting MS-DOS from disk drives, such as the possibility of accidental file corruption or deletion. And it should provide some level of protection against computer viruses.

Another way to acquire DR DOS is to buy the ROS System Builders Kit, which includes DR DOS and software to build ROM images for your own EPROM software. ROS can be set up to always boot from the DR DOS EPROMs or to boot selectively from a disk drive or the EPROMs.

Price: $199; ROS System Builders Kit, $299.
Contact: Award Software, Inc., 130 Knowles Dr., Los Gatos, CA 95030, (408) 370-7979.
Inquiry 1140.



Award Software's ROS Card is just the operating system DR DOS ordered.

Would You Like a DOS System with That Mac?

The Mac/DOS 286sx, a 12-MHz 286 coprocessor card for your Mac II's NuBus slot, lets you take advantage of DOS applications, including networking.

It includes 1 MB of RAM, a serial and a parallel port, and support for Apple's FDHD Superdrive, which means that the Superdrive can read from DOS-formatted 3½-inch 1.44-MB floppy disk drives.

Features include support for Dynafile 5¼- and 3½-inch disk drives and external SCSI drives, plus the ability to transfer and convert files from one format to another.

Price: $1295.
Contact: Univation, Inc., 513 Valley Way, Milpitas, CA 95035, (408) 263-1200.
Inquiry 1134.

Dictating to the Dragon

Dragon Systems recently upgraded its DragonDictate system to recognize 25,000 spoken words. You can also now dictate as fast as 40 words per minute, and you can teach DragonDictate an additional 5000 words, including names, parts numbers, and legal and technical terms.

The system consists of an add-in card for 386 machines (20- or 25-MHz recommended), software that handles word recognition, and a headset microphone. You need at least 8 MB of memory.

The voice-recognition hardware, based on a Texas Instruments 32010 digital signal processor, digitizes the speech and checks each word against its 25,000-word database.

Price: $9000.
Contact: Dragon Systems, Inc., Chapel Bridge Park, 90 Bridge St., Newton, MA 02158, (617) 965-5200.
Inquiry 1136.

continued

Double Your Data Storage Capacity with $199 Card

The InfoChip Expanz! is a compression coprocessor card with a proprietary chip that compresses data on random-access data storage devices, such as floppy and hard disk drives.

Expanz! offers transparent compression and decompression and does not slow your access to the stored data, the manufacturer says. The method of compression is "lossless" as compared to video compression, where a certain amount of data can be lost but is not noticeable when you look at the compressed and decompressed video.

The 8-bit half-length Expanz! will work with any DOS 3.x application and averages a 2.5-to-1 compression ratio. That means that your 20-MB hard disk drive will hold about 50 MB of data, and your 100-MB SCSI drive will hold 250 MB. The overhead for compression on a hard disk drive averages 3 percent of the size of the original hard disk drive, or less than 1 MB in the case of a 20-MB drive.

Once you have Expanz! installed on your XT or AT and you are ready to compress the files on your 20-MB hard disk drive, the compression process takes about 10 minutes.

Thereafter, Expanz! will compress and decompress files as you use your computer. And because you are then reading compressed files (e.g., three sectors of the disk now map to one), the read time is somewhat faster than it was with uncompressed files. The time will not be substantially less for hard disk drive reads, but floppy disk drive reads are said to be about three times faster.

Price: $199.
Contact: InfoChip Systems, Inc., 2840 San Tomas Expy., Santa Clara, CA 95051, (408) 727-0514.
Inquiry 1133.

C Programmers Talk About Their DBMS

Performance "10-50 times faster than any other DBMS."
Bruce Kyle, Software Consultant, Wyatt Software

"We're staggered by the speed of db_VISTA III, which remains constant regardless of file size. This feature, plus impeccable integrity made db_VISTA III an easy conclusion to months of market research."
Stephen Meehan, Programmer/Analyst, Seaboard Life Insurance

Flexibility " Nobody else gives me the flexibility to manipulate my DBMS application like db_VISTA III. And db_QUERY and db_REVISE provide powerful tools for querying and restructuring the database...no other product compares!"
Mark Thomann, Senior Analyst, Taco Bell

Portability "db_VISTA III with source code allowed us to port our Airport Automation System from MS-DOS to Stratus/VOS quickly and painlessly."
Jon Stephenson, President, ICCI

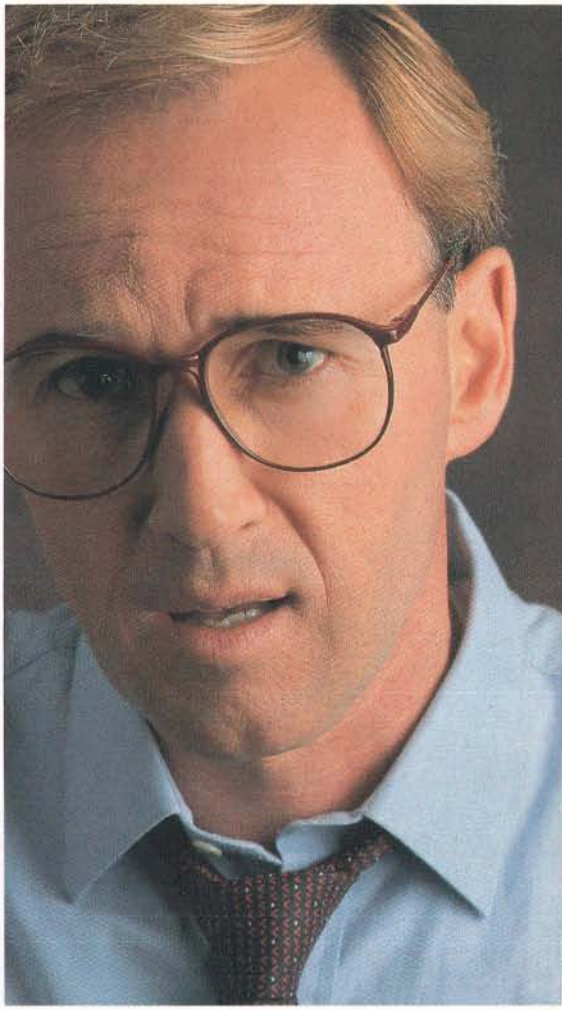
Source Code "db_VISTA III with source code gives me outstanding flexibility and is the best form of documentation money can buy."
Paul Cadaret, President, Unicon

Royalty Free "We chose db_VISTA III because it's royalty-free and written in C. We were able to create a product so much better than anything else on the market that it was selling by word of mouth before the promotional literature went out."
Jeff Bean, President, CWC Software

Value "db_VISTA III on the PC is the only DBMS that I have found sophisticated enough to do the kinds of access tracking we require, and do it quicker and cheaper than the way it is now done on a large VAX cluster system."
Larry Desonier, Member of the Technical Staff, Sandia National Laboratories

db_VISTA III™

Database Management System



C programmers around the world are talking about db_VISTA III from Raima. Call today to discuss your DBMS requirements, and ask for our Lit-Pac that contains technical specifications, benchmarks, and DBMS success stories.

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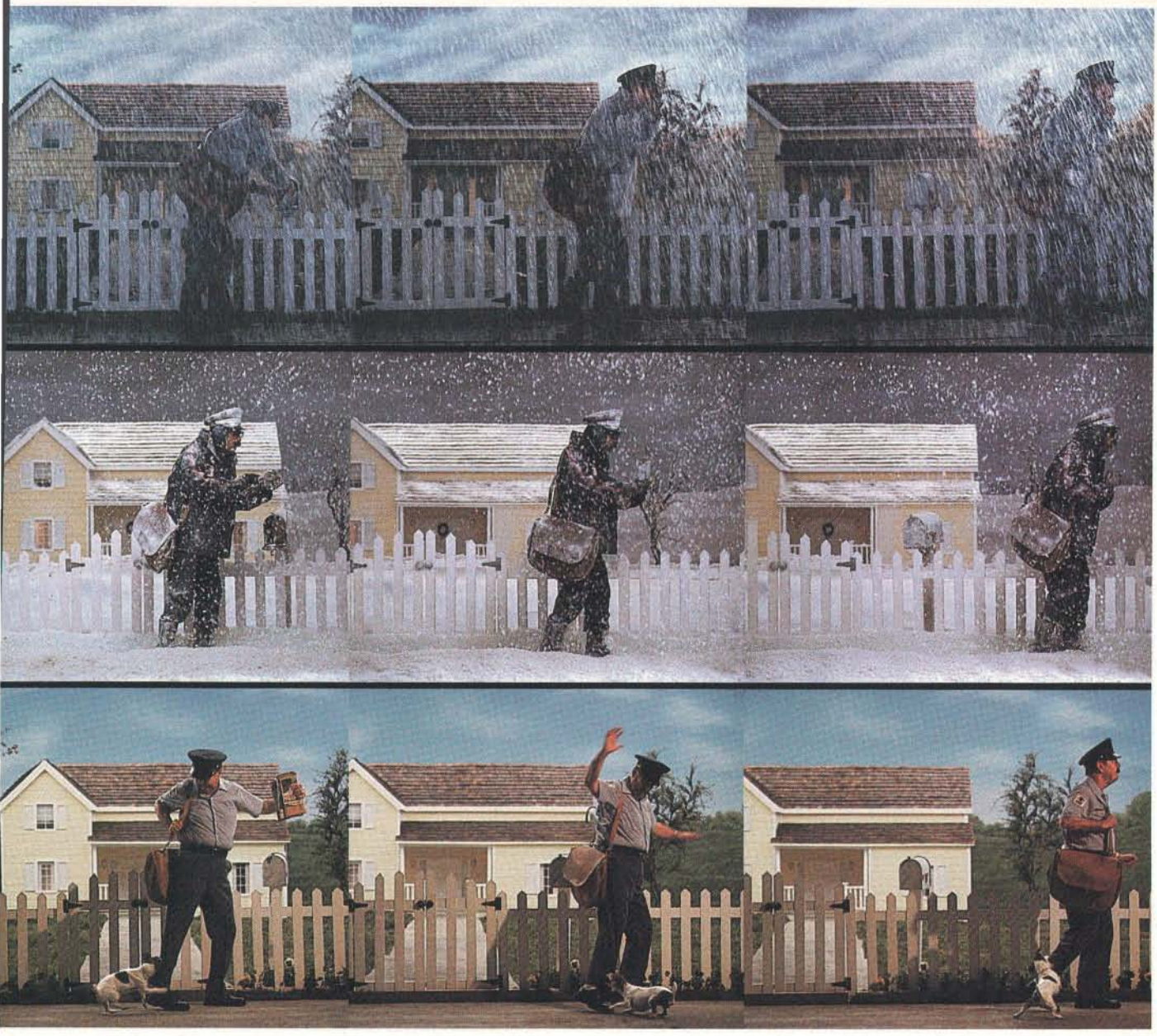

nvironments is our motto, too.

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For more information about the Word family, including our soon-to-be-released OS/2 version, call us at (800) 541-1261, Department L02.

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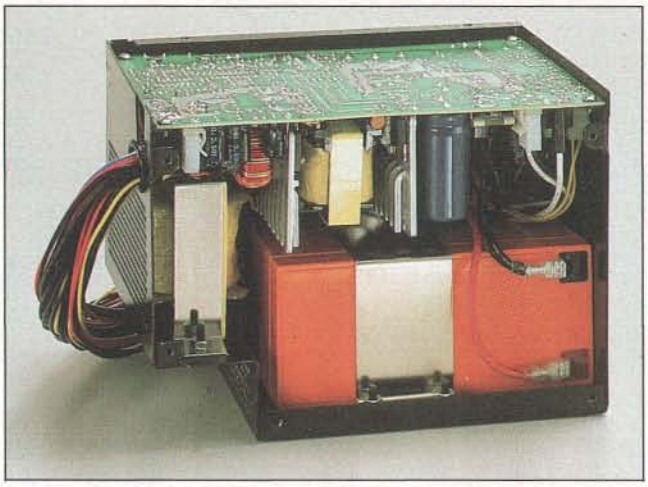
Replace That Old Power Supply with a UPS

The InnerSource 2210 internal uninterruptible power supply from PC Power & Cooling is a power supply with a maintenance-free 12-V battery. It runs for 5 to 10 minutes when the power goes down, sounds an audible alarm, and puts out the equivalent of 300 W of power.

The drop-in replacement power supply comes with Power Watch software from RE Limited. When you leave your system, you leave the floppy disk inserted in the drive. Then if the power goes down, a TSR program boots the floppy disk drive and does an automatic save.

The power supply measures 8⅝ by 5⁹⁄₁₀ by 5⁹⁄₁₀ inches and weighs 14 pounds.
Price: $449.
Contact: PC Power & Cooling, Inc., 31510 Mountain Way, Bonsall, CA 92003, (619) 723-9513.
Inquiry 1141.



This replacement power supply from PC Power & Cooling doubles as a battery-powered backup system.

Step on It

Brown & Co. has upgraded the PC-Pedal to let you duplicate any keyboard key on an XT-, AT-, or PS/2-style keyboard with the press of your foot, the manufacturer claims.

The system consists of a foot switch with a 6-foot cord and a parallel-port adapter that includes its own parallel port, so your printer won't be left without a parallel port.

The (older) standard version duplicates the Shift, Alt, or Control keys and changes the space bar to a Backspace Delete key when you hold the pedal down. The enhanced (new) version lets you duplicate any keyboard key. For example, an Alt or Control key can be assigned as a macro.
Price: Standard version, $59.95; enhanced version, $79.95.
Contact: Brown & Co., Inc., P.O. Box 2443, South Hamilton, MA 01982, (508) 468-7464.
Inquiry 1142.

IOtech Introduces IEEE-488 Interface for the NeXT

The SCSI488/N is an IEEE-488 interface plus software driver that lets your NeXT Computer control up to 14 instruments. Data rates are 900K bytes per second through the SCSI connection.

Included in the thin, rack-mountable SCSI488/N is a software driver that links to Objective C, NeXT's development language. The software includes mouse-compatible IEEE commands and automatically assigns names to instruments, thus eliminating the repetitive details of bus addresses, bus terminators, and data formats.
Price: $1495.
Contact: IOtech, Inc., 25971 Cannon Rd., Cleveland, OH 44146, (216) 439-4091.
Inquiry 1143.

Track the Weather with Your PC

WeatherTrac is a PC-based weather satellite receiving and display system. The software included is geared for marine, agricultural, aviation, utility, educational, and military use.

The system comes with an audio interface peripheral, an acquisition and control card, a VGA card, and software. You need an antenna or dish (or WeatherTrac will sell you one) that can receive satellite feeds.

With WeatherTrac, you can receive information from the National Oceanographic and Atmospheric Administration (NOAA), the Geosynchronous Orbiting Earth Satellite (GOES), Weather Facsimile (WEFAX), European and Soviet satellite transmissions, and High-frequency FM Naval Facsimile (Hf-FM NAFAX). WeatherTrac's receiver and decoding software then displays the information, which can be manipulated with menu-based image-analysis software.

Other features of the software let you manipulate VGA images with up to 64 gray scales and 256 colors. You can also display NOAA Automatic Picture Transmissions on a latitude/longitude grid. Temperature calibrations add earth-positioning information and scene temperatures to the NOAA imagery.

Options include a scheduler for automatic operation, a drawing and graphics package to develop complete weather maps or enhance images, National Television System Committee broadcast-quality output, printers for hard copy, and a directional antenna.

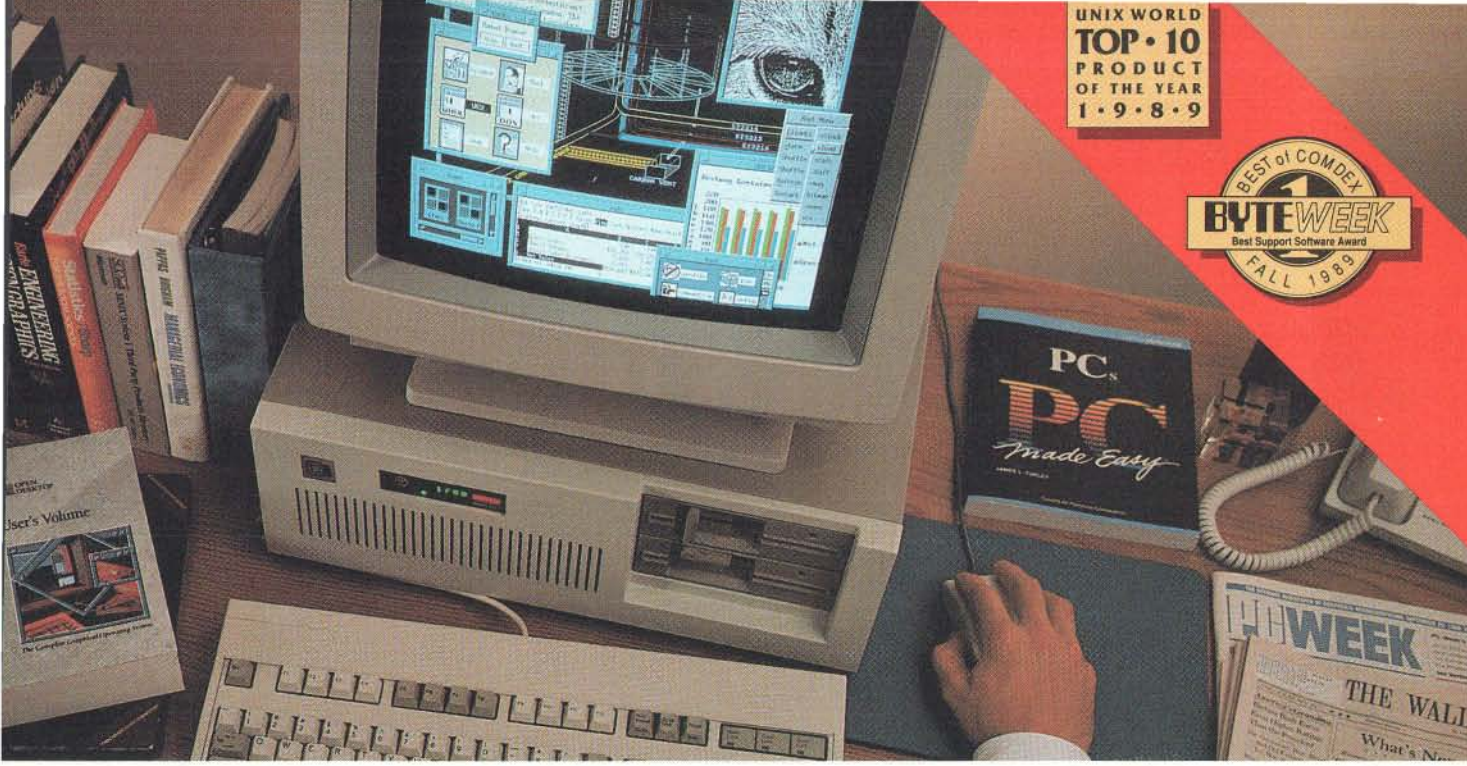
WeatherTrac recommends at least an XT with a hard disk drive.
Price: $3995; with antenna and an XT, $9995.
Contact: WeatherTrac Industries, 860 Worcester Rd., Framingham, MA 01701, (508) 879-4425.
Inquiry 1146.

Scenario Offers Handwriting Recognition Tablet

The DynaWriter is a handwriting recognition system that includes a 10- by 6-inch flat-panel display, an attached stylus, and an 8-bit add-in card with a 6-foot cable.

Scenario claims 98 percent recognition by DynaWriter for any user through neural network technology and some training. LCD resolution is 720 by 400 pixels, and stylus resolution is 100 dpi. The standard system includes applications and some development software.
Price: $1995.
Contact: Scenario, Inc., 260 Franklin St., Fifth Floor, Boston, MA 02110, (617) 439-6611.
Inquiry 1144.

continued



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Take a look at the vast majority of graphical workstations developed over the past decade and you'll see something they all have in common:

An integrated UNIX® System environment.

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Circle 276 on Reader Service Card

Infrared and Radio Transceivers Replace Cabling

Two companies recently introduced transceivers that bypass Ethernet and Token Ring cabling yet remain compatible with the IEEE-standard networks.

The Wireless LAN from Untied TeleCom is networking hardware with infrared transceivers that aid in Ethernet and Token Ring intraoffice transmission (including 4- and 16-Mbps Token Ring networks), the company claims.

PC coaxial cards for either networking hardware (IEEE 802.3 Ethernet or IEEE 802.5 Token Ring) are hardwired to a transceiver, called the Satellite, for LED transmission (800 nanometer wavelengths) of up to 80 feet to a transceiver/server, called the Sun. Satellites can support up to four PCs each with Token Ring and up to 31 PCs each with Ethernet.

With Ethernet, Suns can support up to the Ethernet limit of 1024 PCs. Token Ring Suns can support eight Satellites. Communication between the Satellites and Suns is full-duplex (bidirectional). And Suns and Satellites can detect optical collisions.

Price: Ethernet Satellites, $1000; Token Ring Satellites, $1250; Ethernet Suns, $2000; Token Ring Suns, $3000.

Contact: Untied TeleCom, Inc., 100 Mechanic St., Building 8L, P.O. Box 280, Southbridge, MA 01550, (508) 765-0776.

Inquiry 1150.

An infrared transceiver from Untied TeleCom connects you with Ethernets and Token Rings.

A new pair of Ethernet transceivers for the hand-held Agilis 8088- and 386-based computers lets them communicate at data rates of up to 230,000 bps, the company claims.

The range is 100 meters indoors and 1 kilometer outdoors from one mobile Agilis to another or to an Ethernet backbone. The main bus on the Agilis works at the Ethernet speed of 10 Mbps.

The 8⅘- by 7½- by 1-inch mobile Network Module plugs into the hand-held Agilis like any other "slice" or module. On the Ethernet backbone, you need another Network Module and an optional thin-coaxial adapter that converts the data rate from 230,000 bps to Ethernet rates.

The Agilis system comes with Radio Manager software, which allows you to select from a total of 16 different channels.

Price: $2495; wiring adapter, $125.

Contact: Agilis Corp., 1390 Shorebird Way, Mountain View, CA 94043, (415) 962-9400.

Inquiry 1149.

The Agilis CPU sits atop a wireless Ethernet transceiver.

New Menu-Driven Crosstalk Emulates Its Predecessor

Version 2.0 of the Crosstalk Mk.4 communications software can emulate Crosstalk XVI, and it makes frequent use of menus, a feature that has become almost commonplace in other software packages. Users can now choose whether to use a new menu-style "dialing directory," the old two-letter command-line interface of Crosstalk XVI, or the more powerful command-line interface of Crosstalk Mk.4 version 2.0 with its extensive script language. The new version is memory-resident and takes up 300K bytes of memory.

Crosstalk Mk.4 is known for its ability to support synchronous communications with mainframes and the ability to support multiple communication channels at the same time. Digital Communications Associates has expanded these capabilities by adding more terminal emulation capabilities to version 2.

Price: $245; Mk.4 upgrade, $65; Crosstalk XVI upgrade, $85.

Contact: Digital Communications Associates, 1000 Alderman Dr., Alpharetta, GA 30201, (404) 442-4987.

Inquiry 1157.

Telecommute the Easy Way

AboveX is a file transfer program for DOS and OS/2 users who don't have access to a data communications network but need to send files electronically. A text editor that lets you send cover memos with your files and a simple database for addresses are also included.

The program provides a log of incoming and outgoing calls. When receiving files, you can view selected files. And when you send files, the calls sent during off-time business hours are tracked and the savings calculated for you.

If data security is important, you have 10 levels of security available, and you can encrypt the data in three ways.

AboveX includes a self-configuring installation procedure, automatically initializes the modem, and dials numbers and answers calls with auto-redialing in the foreground or background.

AboveX runs on the IBM PC and compatibles running DOS 3.0 or higher or OS/2. You also need a modem.

Price: $495.

Contact: Above Software, Inc., 3 Hutton Ctr., Suite 950, Santa Ana, CA 92707, (714) 545-1181.

Inquiry 1152.

continued

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Logitech™ Series 9 Mouse. *Awarded rave reviews for its comfortable shape, adjustable resolution and ballistic drivers for flick-of-the-wrist control. Includes Pop-Up DOS™ and mouse menus to mousify almost any application. SRP: Serial-$119, Bus-$139, PS/2-$119, Serial & PS/2-$149.*

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Circle 176 on Reader Service Card (DEALERS: 177)

File Management for NetWare

LAN Director is a file management software package that works with up to eight servers and 208 logical devices (drives) that are connected by NetWare.

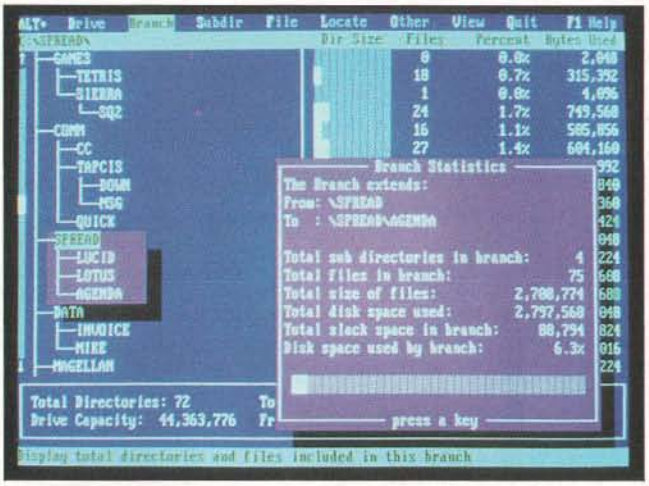
LAN Director helps you accomplish file management tasks such as file copying, moving, browsing, and editing. It also offers a complete graphical tree that helps you navigate through the files by identifying which drives are local to the node, which are file server drives, which are mapped drives, and which are search drives. (Mapped drives are a function of NetWare that provides you with virtual drives, and search drives are Novell's answer to the path command.)

And if you lose a file, 11 different search algorithms locate files by file specification, creation date, byte size, keywords, and text contents. Special features include an editor, ZIP and ARC searches and listings, and support for VGA graphics.

Price: $295.

Contact: Athena Software, 4915 Twin Lakes Rd., Suite 19, Boulder, CO 80301, (303) 530-0693.

Inquiry 1151.



LAN Director logically displays your NetWare network and helps you direct files across multiple servers.

Finding LAN Faults at Half the Price

Cabletron's new LAN diagnostics tool, a protocol analyzer called LANview, offers 80 percent of the functionality of other protocol analyzers for half the price.

The Ethernet LAN analyzer tests and monitors network activity with filtered packet analysis, traffic generation, and a time-domain reflectometer. And it reports bandwidth utilization, transmission errors, and failed nodes.

LANview runs on a PC and decodes all major protocols (including TCP/IP and AppleTalk). It uses optional transceivers that can work with cabling and optical fiber.

Price: $11,995; transceiver, $100 to $250.

Contact: Cabletron Systems, 35 Industrial Way, Box 6257, Rochester, NH 03867, (603) 332-9400.

Inquiry 1147.

Make Dumb Terminals Smart

The DataLink 286 is a slave processor card for your NetWare server that provides intelligence, in the form of a 286 microprocessor, for your ASCII, ANSI, or PC terminals.

With the DataLink 286, local and remote terminals are transformed into diskless LAN workstations. Or you can use DataLink 286 with modems for remote call-ins to your LAN database, for example.

Each DataLink 286 contains two ATs. Each AT has three serial ports (for terminal connection, modem, and serial printer), one parallel port, 1 MB of RAM, one Hercules controller, and one socket for an 80287 math coprocessor.

NetWare workstation drivers and terminal drivers for a variety of terminals are included with each DataLink.

Price: 12-MHz, $2295; 16-MHz, $2450; 20-MHz, $2595.

Contact: Data/Voice Solutions Corp., 16842 Von Karman, Suite 200, Irvine, CA 92714, (714) 474-0330.

Inquiry 1148.

continued

Device IDs Phone Callers, Links Them to dBASE Files

The Caller ID+Plus is a DOS-based TSR program and a 2-inch-square serial adapter that work in conjunction with the telephone company service Caller ID. When you get a telephone call, Caller ID+Plus not only identifies the telephone number of the person who's calling, it also automatically pops up your dBASE III file on the caller, according to Rochelle Communications.

When the call comes in, Caller ID+Plus needs at least two rings to identify the caller and to display the dBASE III file. Once the dBASE III file is displayed, two other windows also pop up: One is a call-history file maintained by Caller ID+Plus, and the other is basically an editor for notes about the caller.

The Caller ID+Plus device measures about 2 by 2 by 2 inches and has two ports: one for your computer's serial (9- or 25-pin) interface, and one that's an RJ-11 phone connector. The software is a 30K-byte memory-resident package that operates in the background on a PC with at least 512K bytes of RAM.

A line-status monitor detects whether an incoming call is answered, allowing the PC to measure the duration of the call and keep track of unanswered calls so you have the caller's telephone number handy when you decide to return a call. A diagnostic and installation feature lets you verify whether your selection of COM1 or COM2 is appropriate.

Caller ID is available today only to Bell Atlantic and BellSouth customers. But its roots are in the latest version of telephone company testing software called Signaling System version 7 (SS7), so many more phone companies will at least have the technology to offer Caller ID in the near future. Today's Caller ID services are offered by the Bell Operating Companies only within the Local Access Transport Areas and can therefore identify callers only from within LATAs. LATA borders are usually synonymous with borders for area codes.

Price: $185.

Contact: Rochelle Communications, Inc., 8716 North Mopac, Suite 200, Austin, TX 78759, (512) 794-0088.

Inquiry 1153.

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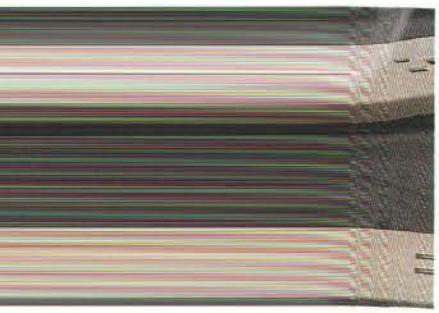

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The

Now, Q

Memory is gold.

And like gold, some of it is hidden away inside your computer. For years, we've been working toward putting it all under your control. And now we can.

Now you can make today's more powerful programs run without giving up network and mouse drivers and TSRs.

Introducing Quarterdeck Manifest —the memory analyzer

Many PC users know there are nuggets of memory sitting unused in most PCs. But those little pieces of memory can add up to 130K!

That's why Quarterdeck Office Systems, publisher of DESQview, developed a new utili that helps you find and use this memory. It's called Manifest. And it does for memory what PC Tools does for disks. For under $60.

Quarterdeck's seven years of memory expertise made Manifest

Manifest guides you deep inside your PC.

It locates unused (or underused) memory and suggests where you could load networks, buffers, mouse drivers, TSRs and other utilities to increase performance. It even analyzes what type and amount of RAM you have available, and which portions of your memory are faster.

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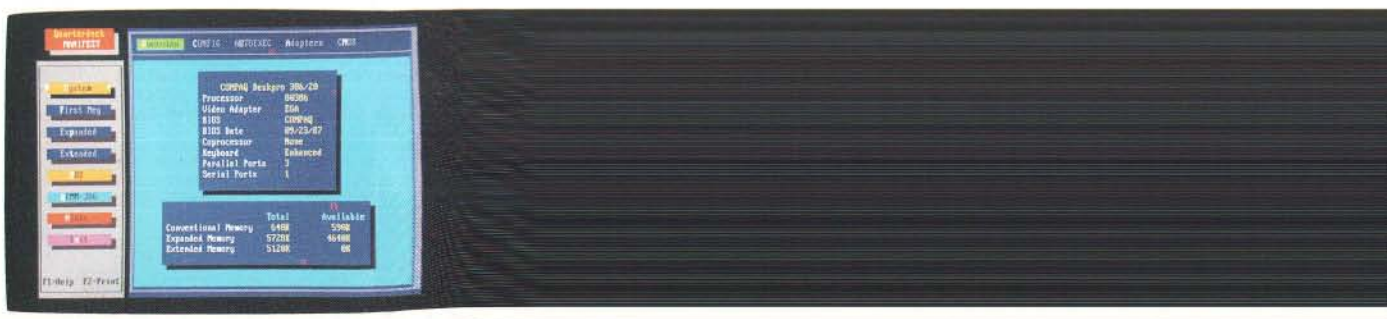

Manifest shows you how your memory works. Here first megabyte of RAM, showing unused areas.

"So, this punk comes up to me and says, 'Is there anything you won't do for a buck?' And I say, 'Sure. I won't plug in my PC without a Proxima product to protect it.'"

"I may be crazy, but I'm not stupid."

"When people tell me I take foolish risks, I say to them: 'At least I assess the risks, and I always take steps to protect myself. Do you?'

"Take many microcomputer users. They're cool and calm, just cruising along until – *wham!* – they've crashed. Lost all their data, maybe even burned out a motherboard. Yet they sit there, stunned. They had no idea they were at risk.

"Or maybe they just thought it would never happen to them. Yet studies indicate that every AC outlet in America has a 97% probability of incurring at least one system-damaging event each year.

"Whether it's a Proxima® ProLine™ Surge Suppressor that clamps down on incoming surges and spikes – or a Power Director® that protects against power problems *and* acts as a power control center – your micro needs ultra-reliable protection against the 101 power problems that threaten it.

"So check out the entire range of innovative Proxima Power Protection Products. And ask about the Proxima **Lifetime Equipment Protection Policy.** With the purchase of a ProLine 20 or 30, or a Power Director, it guarantees the survival of your hardware from a power problem – for life."

Whether you're operating a home computer or a technical workstation, there's a state-of-the-art Proxima ProLine to match your needs.

Want to hear more about how to save the life of your computer? Just write, and I'll send you, free, "Five Ways to Stop Being a Computer Daredevil." Or call 800/582-2580 (800/582-0852 in CA).

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Return to: Computer Accessories Corp., 6610 Nancy Ridge Dr., San Diego, CA 92121 619/457-5500.

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by Computer Accessories Corporation

Power Director and Proxima are registered trademarks, and ProLine is a trademark, of Computer Accessories Corp.

There's gold

Now, Quarterdeck's new

Memory is gold.

And like gold, some of it is hidden away inside your computer. For years, we've been working toward putting it all under your control. And now we can.

Now you can make today's more powerful programs run without giving up network and mouse drivers and TSRs.

Introducing Quarterdeck Manifest —the memory analyzer

Many PC users know there are nuggets of memory sitting unused in most PCs. But those little pieces of memory can add up to 130K!

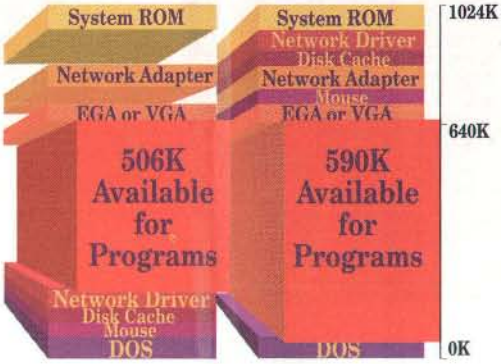
That's why Quarterdeck Office Systems, publisher of DESQview, developed a new utility that helps you find and use this memory. It's called Manifest. And it does for memory what PC Tools does for disks. For under $60.

Quarterdeck's seven years of memory expertise made Manifest

Manifest guides you deep inside your PC.

It locates unused (or underused) memory and suggests where you could load networks, buffers, mouse drivers, TSRs and other utilities to increase performance. It even analyzes what type and amount of RAM you have available, and which portions of your memory are faster.

Manifest shows you how your memory works. Here's the first megabyte of RAM, showing unused areas.



Your current memory is full of holes. Our tools can fill blocks of unused addresses between 640K and 1024K to free up memory your programs can use.

Manifest shows you the contents of AUTOEXEC.BAT and CONFIG.SYS files. That can be a big help when diagnosing problems. Manifest tells you all about your hardware, too —from your cpu type to what boards you have installed. Manifest even tests memory speed. And it runs benchmark tests on expanded memory boards so you can make informed buying decisions.

Administering a number of PCs? Manifest's diagnostic and reporting capabilities reduce technical support time . It not only identifies problems but helps to solve them.

You won't need a PhD to understand what you're doing. Manifest has an interactive 'manual' that tells you how to use the program and what benefits you'll get.

And unlike a lot of hot new software, Manifest works on virtually any PC: 8088, 8086, 80286 or 80386. It's a productivity breakthrough from the memory experts at Quarterdeck.

INFO WORLD BEST IN ITS CLASS Dec. 18, 1989

Introducing QRAM—the Quarterdeck memory optimizer

End RAM cram in your 8088, 8086 or 80286 PC once and for all. QRAM (pronounced cram), is a package of utilities that gives you unprecedented control over memory, letting you set up your memory the way it will work best for you.

If you have EMS 4.0 or EEMS boards, QR can find unused addresses and 'map' memory those addresses. Then it looks at your AUTO-EXEC.BAT and CONFIG.SYS files and figures out what TSRs, network and mouse drivers a DOS resources can be loaded high and where.

And, like all Quarterdeck memory produc QRAM is compatible with the Microsoft XMS specification used by Windows 286, V. 2.x.

If your PC has 'shadow RAM,' there's eve

QRAM optimizes your memory performance by mov utilities and drivers out of the area between 0K and 6 — freeing it up for your programs to use.

more gold in your PC. QRAM finds the unus parts and puts them under your control.

And if you have an EGA or VGA-equipp PC and don't need graphics at the moment, QRAM will make an additional 96K 'nugget' memory available! When you need graphics again, QRAM will switch you back to graphi mode! Think how helpful that will be for thos big dBASE files.

It can't work miracles, but if there's mem available anywhere, QRAM lets you use it to increase your PCs speed and performance.

QRAM is available bundled with Manife for just a few dollars more than Manifest alor

Manifest and QRAM—two more exampl of Quarterdeck's commitment to mining the most productivity out of the PC and softwar you own today.

in your PC.

ools can mine it for you.

Introducing QEMM 50/60 Version5.0

QEMM (Quarterdeck Expanded Memory Manager) 50/60 is the gold standard in memory management for the IBM PS/2™ series 50 and 60. It works with IBM's Memory Expansion Option, Expanded Memory Adapter/A and compatible memory boards.

It supports all three specifications for expanded memory: EMS 4.0, EMS 3.2 and EEMS memory so you can run all expanded memory programs.

And it also works with Microsoft's XMS specification, in case you want to use Windows.

QEMM lets you use memory locations between 640K and 1024K to run TSRs, mouse and network drivers, DOS resources and MCA adaptors. That means you can gain up to 130K of memory space below 640K for your programs.

Best of all, QEMM is designed to be easy to use—even for those new to the PC. Just install it and type 'optimize,' and it looks at your AUTOEXEC.BAT and CONFIG.SYS files and loads whatever it can in high memory. Automatically.

QEMM 50/60 is priced economically. It's the biggest boost you can give your PS/2 for under $100.

QEMM and DESQview let you multitask and window with the programs you know and use today.

Introducing QEMM 386 Version5.0

QEMM 386 can expand the memory of all 386-based computers, including PCs with 80386 upgrade boards. It makes your memory compatible with EMS 4.0, EMS 3.2 and EEMS memory without having to add special hardware. It's compatible with protected-mode programs (like 1-2-3 Release 3, IBM Interleaf and Paradox 386) using DOS extenders compatible with the Quarterdeck/Pharlap VCPI spec.

QEMM also works with Microsoft's XMS spec to extend memory for Windows users.

QEMM gives you maximum control over your memory between 640K-1024K. It can find unused memory nuggets as small as 4K and use them to free up room for programs to use.

QEMM 386 even monitors how your programs use memory while they're running. Then it shows you where there's additional memory you can use. It even measures which parts of your memory are fastest and 'decides' how to use them for better performance. In action, it's easy and fun—almost like having an *artificial intelligence* program to help tune up your PC.

All these capabilities add up to greater performance at a very low cost. And QEMM lets you go for the gold without having to become an expert on the PC memory puzzle.

Like all Quarterdeck products, it works with your current PC and favorite software.

A few words about DESQview

What's the smartest thing to do with all that additional memory? Run DESQview and multitask your favorite programs in windows. Use a mouse or keyboard and you can run graphic and text-based programs side-by-side. All without having to invest in a bigger hard disk or more memory.

DESQview's recent awards.

From Manifest to QRAM, QEMM and DESQview, Quarterdeck helps you mine the most from the software and PC you have today.

System Requirements

Manifest: 8088, 8086, 80286 80386 and i486 PCs & PS/2s

QRAM: 8088, 8086, 80286 PCs. Use of high memory is only available when PC has EMS 4 or EEMS expanded memory or Chips & Technologies shadow RAM.

QEMM 50/60: 80286-based PS/2s and compatibles with IBM PS/2 80286 Memory Expansion Option, IBM PS/2 80286 Expanded Memory Adapter/A or compatible.

QEMM-386: 80386-based PCs and PS/2s and PCs with 80386 add-in boards.

Trademarks: IBM, PS/2: IBM Corporation; PC Tools: Central Point Software; 80386, i486: Intel Corporation, Chips and Technologies: Chips and Technologies

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Qty	Product	5-1/4	3-1/2	Each	Totals
	Manifest 1.0			$59.95	
	QRAM and Manifest 1.0			$79.95	
	QEMM 50/60 5.0 (with Manifest*)			$99.95	
	QEMM 386 5.0 (with Manifest*)			$99.95	
	Shipping & Handling $5 in USA/ $10 outside USA				
	California Residents add 6.5%				
	Grand Total				

*Introductory offer extended to 6/30/90

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Circle 263 on Reader Service Card

Windows 3.0 Arrives

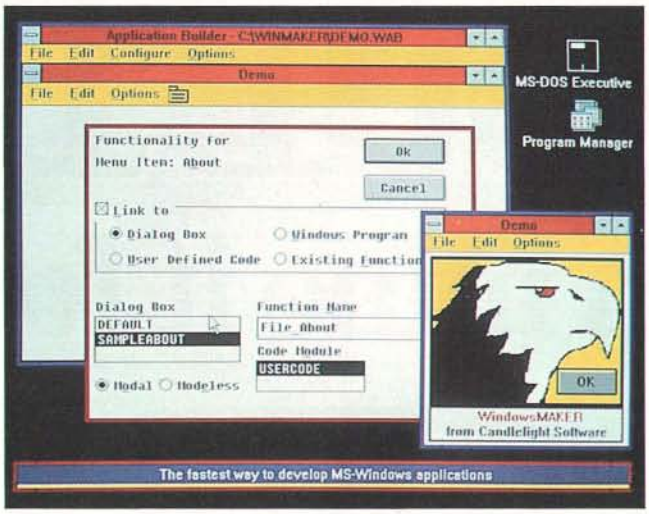
We've all heard by now about the development of Windows 3.0 (see this month's cover story, "Three's the One"). According to Microsoft, about 1500 developers have been working with beta versions of the new Windows, and many applications and tools have been finished for some time. Here are just a few Windows programming tools that are shipping now or will be released within the next month.

Two Application Environments for Microsoft Windows

WindowsMaker, Candlelight's environment for Microsoft Windows programmers, includes a WYSIWYG application generator and a quick-start menu that gives you access from any screen to the Microsoft Software Development Kit and other tools. WindowsMaker lets you design an application's user interface and automatically generate commented C code that you can link to an existing dialog box, custom code, or other Windows applications. If you need to modify a screen's appearance, you can place custom code into protected modules so that only the code that you've modified is recompiled, Candlelight says.
Price: $595; WindowsMaker for Windows 3.0, $795.
Contact: Candlelight Software, 2375 East Tropicana Ave., Suite 320, Las Vegas, NV 89119, (702) 456-6365.
Inquiry 1158.

ProtoView's Screen Management Facility includes a WYSIWYG screen painter, a code generator, and a macro language that lets you incorporate automatic field verification into your data-entry applications without writing a line of code.

ProtoView contains a dynamic link library of over 150 C language functions for business applications and a second library with nine types of editing controls, including source code.
Price: $595.
Contact: ProtoView Development Corp., 162 Kingdom Ave., New York, NY 10312, (718) 948-5195.
Inquiry 1159.



WindowsMaker, here running under the Windows 3.0 program manager, lets you debug an application as it executes.

A Visual Command Language for Windows

ObjectScript, a visual object-oriented programming language for Windows, lets you turn any graphical bit map or metafile image into a button that can integrate and automate Windows applications and access dynamic link libraries. According to Matesys, the language lets you link a Windows word processor, database, spreadsheet, and other applications without having to struggle with the Dynamic Data Exchange facility of Windows.

With ObjectScript, you can convert a graphical image such as a map into a button so that, by clicking on a specific section of the map, a user can access spreadsheet or database data that pertains to that region. You can also use ObjectScript to dynamically link applications with communications programs.
Price: End-user version, $150; programmer's version, $300.
Contact: Matesys Corp., 2001 L St. NW, Suite 801A, Washington, DC 20036, (202) 785-0770.
Inquiry 1162.

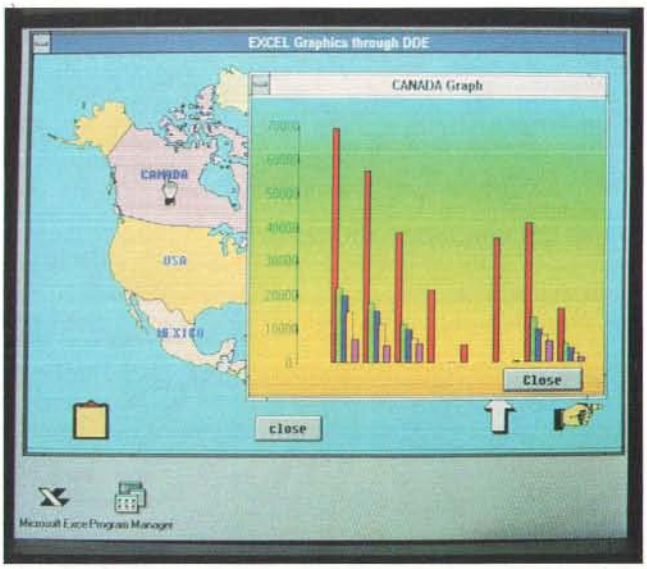
Combine Business with Reasoning in Kappa

The new version of Kappa, a programming environment that lets you add intelligence to a business application, offers improved performance. It also offers a revised syntax for its programming language, which resembles interpretive C, its developer reports.

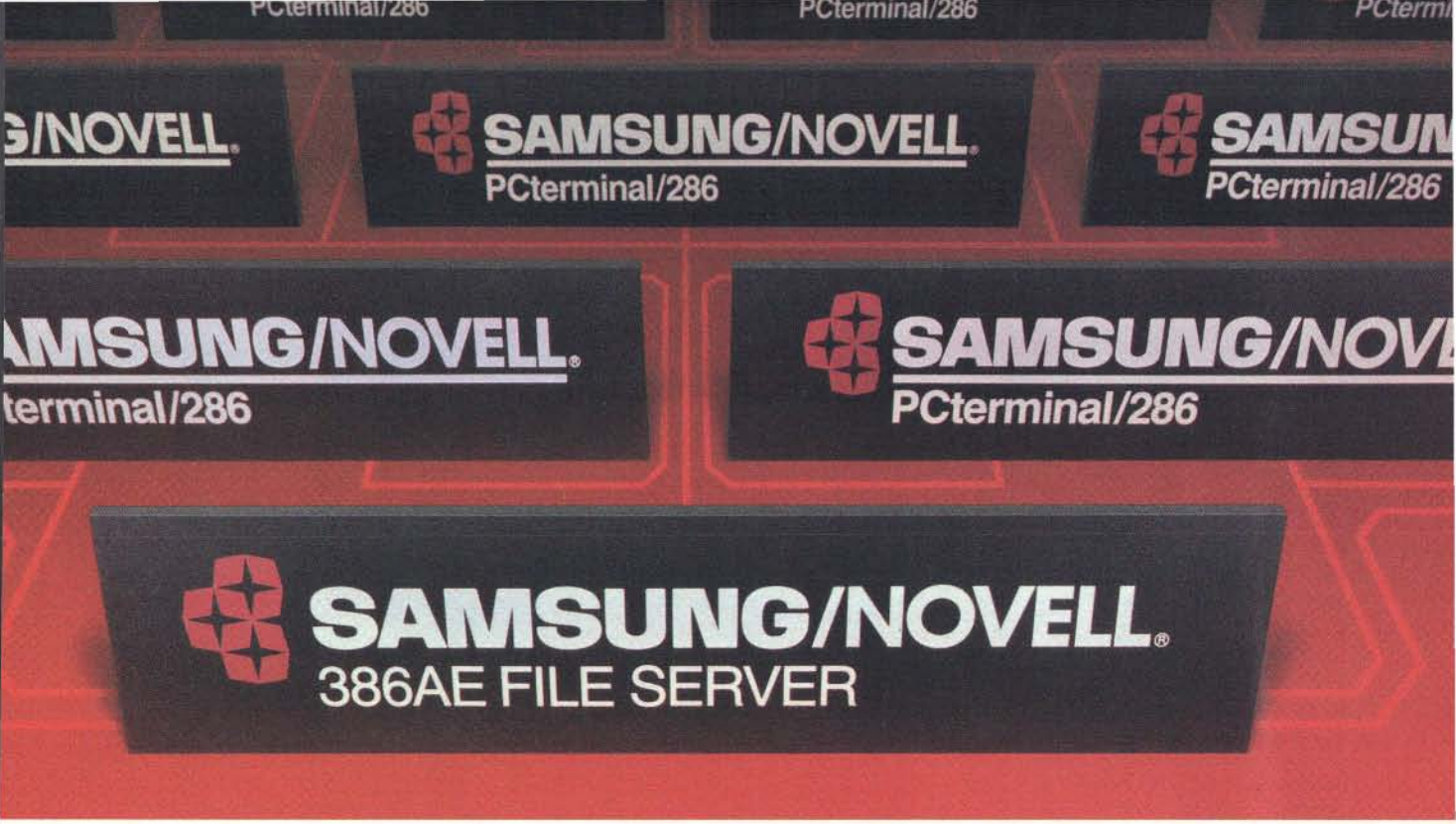
Written in C, Kappa includes graphical tools for examining rules and how they relate to other rules, a debugger, and interfaces to applications such as Lotus 1-2-3 and dBASE.

Kappa is now distributed by IntelliCorp, which recently acquired Kappa's original developer, MegaKnowledge. The version for Windows 3.0 is expected to ship sometime this summer.
Price: $3500; run-time versions, $450.
Contact: IntelliCorp, Inc., 1975 El Camino Real West, Mountain View, CA 94040, (415) 965-5500.
Inquiry 1164.

continued



With ObjectScript, you can convert any image into a button.



How to plan your LAN.

You'll need a pencil.

That's to write down the telephone number on the bottom of this page. Which will connect you with Samsung's nationwide network of resellers. And the Samsung/Novell co-labeled line of LAN hardware.

With one call you can plan on substantial savings over the big name computers which, despite high clock rates and even higher price tags, are not really optimized for networking.

And you can plan on 100 percent compatibility with all versions of Novell's NetWare®, because Samsung's LAN hardware was co-designed by Novell.

THE TESTING WENT IN BEFORE THE LABEL WENT ON.

Samsung's 386AE and PCterminal/286 have been tested exhaustively and certified by Novell for compatibility with all popular networking products. In fact, Samsung's 386AE is one of 3 fileservers certified by Novell to run NetWare 386.

Novell's engineers successfully tested the PCterminal/286 in 1200 network configurations...with 50 units running at once! No other computer manufacturer can make that claim.

NETWORKING VS. NOTWORKING.

What's the difference? Take our 386AE Fileserver. It includes Novell's Advanced BIOS and 8 expansion slots to accommodate multiple network interface cards and disk controllers. Plus an oversize power supply for driving dual high capacity hard disks and tape backup system. Plus 4 megabytes of memory for disk caching.

Then there's Samsung's PCterminal/286 Diskless Workstation with a built-in Ethernet interface and Remote Boot EPROM.

And not to be overlooked is our 16-bit SE2100 Ethernet Interface Card which provides up to twice the throughput for the price of an 8-bit card.

CALL TODAY.
For the name of the Samsung reseller nearest you, call us today at **1-800-624-8999, ext. 851.**

WINNER OF LAN TIMES READERS CHOICE
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PCterminal/286

The 386AE and PCterminal/286. More than affordable. SAMSUNG

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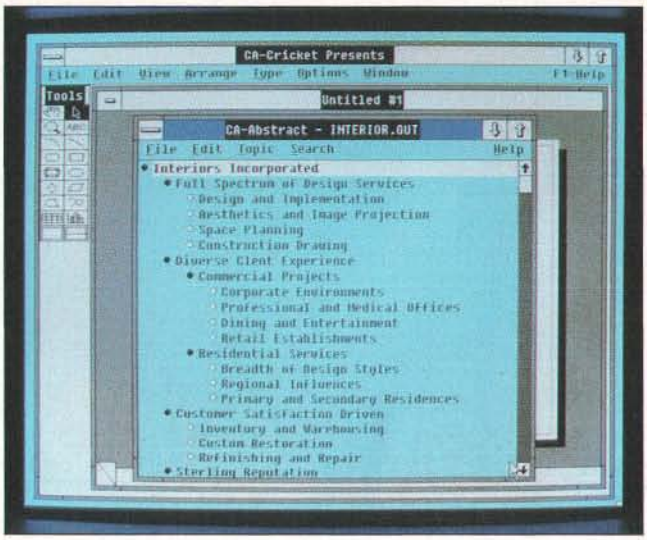
Desktop Presentations Made Easy in Windows

CA-Cricket Presents, a desktop presentation program for Microsoft Windows, lets you organize ideas with its outliner, select a style template, and—using the Auto Presents feature—quickly generate a presentation complete with consistent text, graphs, and background graphics. The program, which includes drawing, graphing, and table tools, lets you explode graphical files so that you can move elements of electronic clip-art files to best suit your format. A Virtual Memory Manager lets you include up to 985 frames per presentation, depending on the amount of system memory.

When working with a graph or table template, you need only enter numbers. The graph will change to reflect the numbers, but the colors and general layout remain the same. An electronic light table lets you rearrange and resequence slide frames, sort by title or image, and reuse frames from other presentations.

The program works with most graphics formats and business application data, can generate speaker's notes, and supports manual or automatic frame advance.
Price: $495.
Contact: Computer Associates International, Inc., 1240 McKay Dr., San Jose, CA 95131, (800) 531-5236 or (408) 432-1727.
Inquiry 1165.



The outline processor included with CA-Cricket Presents for Windows lets you organize thoughts and automatically generate presentation frames.

Manage Portfolios on the Mac

Professional Investor is for stockbrokers, financial planners, and portfolio managers who want to track their clients, portfolios, and transactions on the Mac. Based on HyperCard, the program maintains a history of all transactions for each client's portfolio(s). Each portfolio can have its own central asset account and margin account.

The program keeps track of each tax lot (for calculating capital gains) and lets you sell partial lots. You can access margin accounts for stock and bond transactions.

The program logs calls, and you can dial from within the program if your Mac has a modem. Other features include a database of securities and a quote downloading function.
Price: $349.95.
Contact: Balthrop, Brader, Wood Associates, 5659 Glacier Dr., Springfield, OR 97478, (503) 741-2225.
Inquiry 1167.

Estimate Optimal Financial Solutions in Minutes

The new memory-resident financial analysis program from Timeslips is aimed primarily at lawyers, bankers, accountants, and financial planners. But you can also use it as a personal finance tool by entering known values for loans or investments and letting the program give you the calculated payments, dates, total interest paid, and more.

PercentEdge lets you analyze mortgages, amortization, present value, and variable-rate transactions. You can pop up the program without exiting your current application, and PercentEdge files can be exported to spreadsheets and databases. A pop-up calculator and calendar are available.

PercentEdge runs on the IBM PC with at least 320K bytes of RAM.
Price: $99.95.
Contact: Timeslips Corp., 239 Western Ave., Essex, MA 01929, (508) 768-6100.
Inquiry 1166.

File Converter Added to PC-File 5.0

For users of older versions of PC-File who want to convert their database to PC-File 5.0, ButtonWare has added a utility called Fconvert. The utility asks you a series of questions, at the end of which you have a new PC-File 5.0 database. PC-File 5.0 has more than 50 new features, including mouse support, telephone dialing and phone log, improved dBASE index compatibility, multiple input screens, and a maximum of 128 fields.

PC-File 5.0 runs on the IBM PC with DOS 2.0 or higher and 512K bytes of RAM.
Price: $129.95.
Contact: ButtonWare, Inc., P.O. Box 96058, Bellevue, WA 98009, (206) 454-0479.
Inquiry 1168.

Accounting Program Tracks Inventory and Cost

One-Write Plus, a customizable accounting program for small businesses, now includes a SuperTrack feature that lets you track hours and costs per job, income and expenses per inventory item, and other unique aspects of your operation.

Other new features include budgeting, bank reconciliation, and speed search.

One-Write Plus 2.06 runs on the IBM PC with 640K bytes of RAM.
Price: General ledger, accounts payable, accounts receivable, $299; payroll, $149.
Contact: Great American Software, Inc., 615 Amherst St., P.O. Box 2066, Nashua, NH 03063, (603) 889-5400.
Inquiry 1170.

continued

You need to work on several jobs at once.

OS/2 can do!

Until now, working on several jobs at the same time was next to impossible. But with OS/2®, you don't have to wait for your computer to complete one job before starting another.

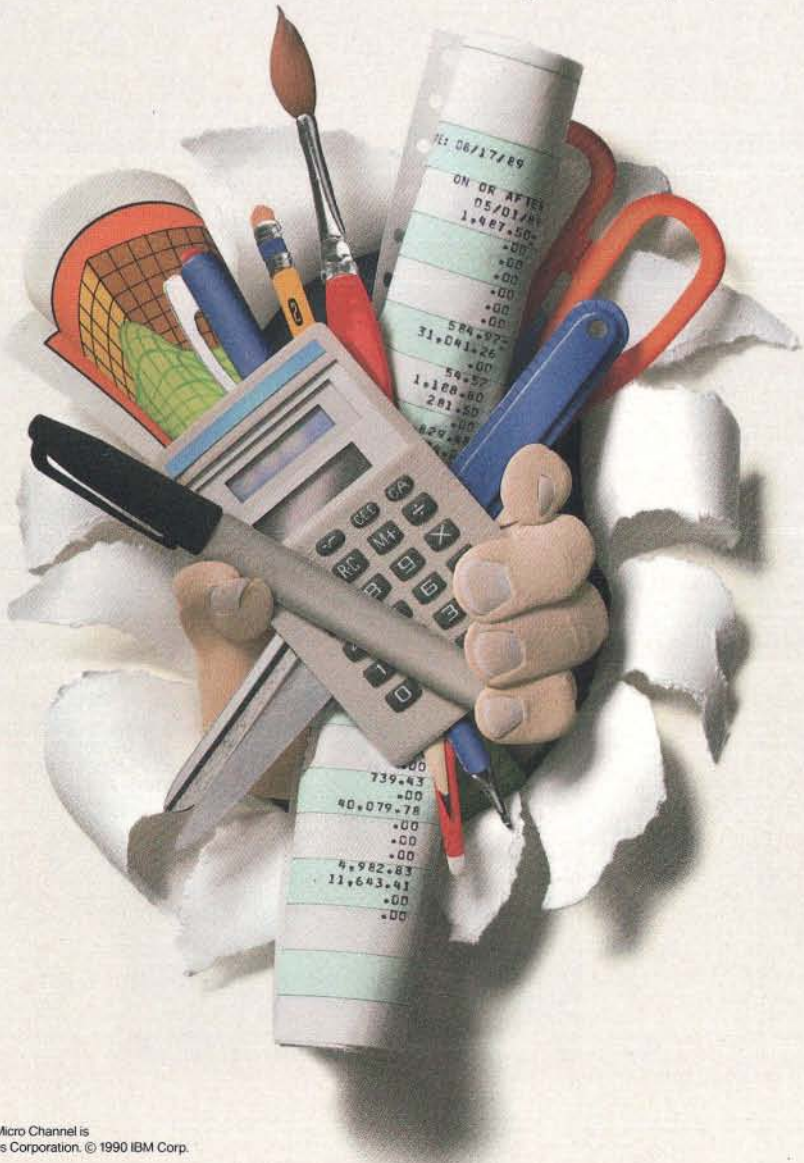
While you're recalculating a spreadsheet or printing a document under OS/2, you can also start a communications session with another office. Your computer can work on those jobs in the background while you do something else, like run a DOS application or work on an unexpected request.

You can take OS/2's multitasking ability even further with IBM's Micro Channel™. Its multiple lanes can handle the heavier flow of information and make your computer one of the most reliable and versatile business tools you can get your hands on.

Want to juggle several things at once? With OS/2, the solution is IBM.

Find out more about OS/2. Contact your IBM Authorized Dealer or marketing representative. For a dealer near you, call 1 800 IBM-2468, ext. 107.

IBM®



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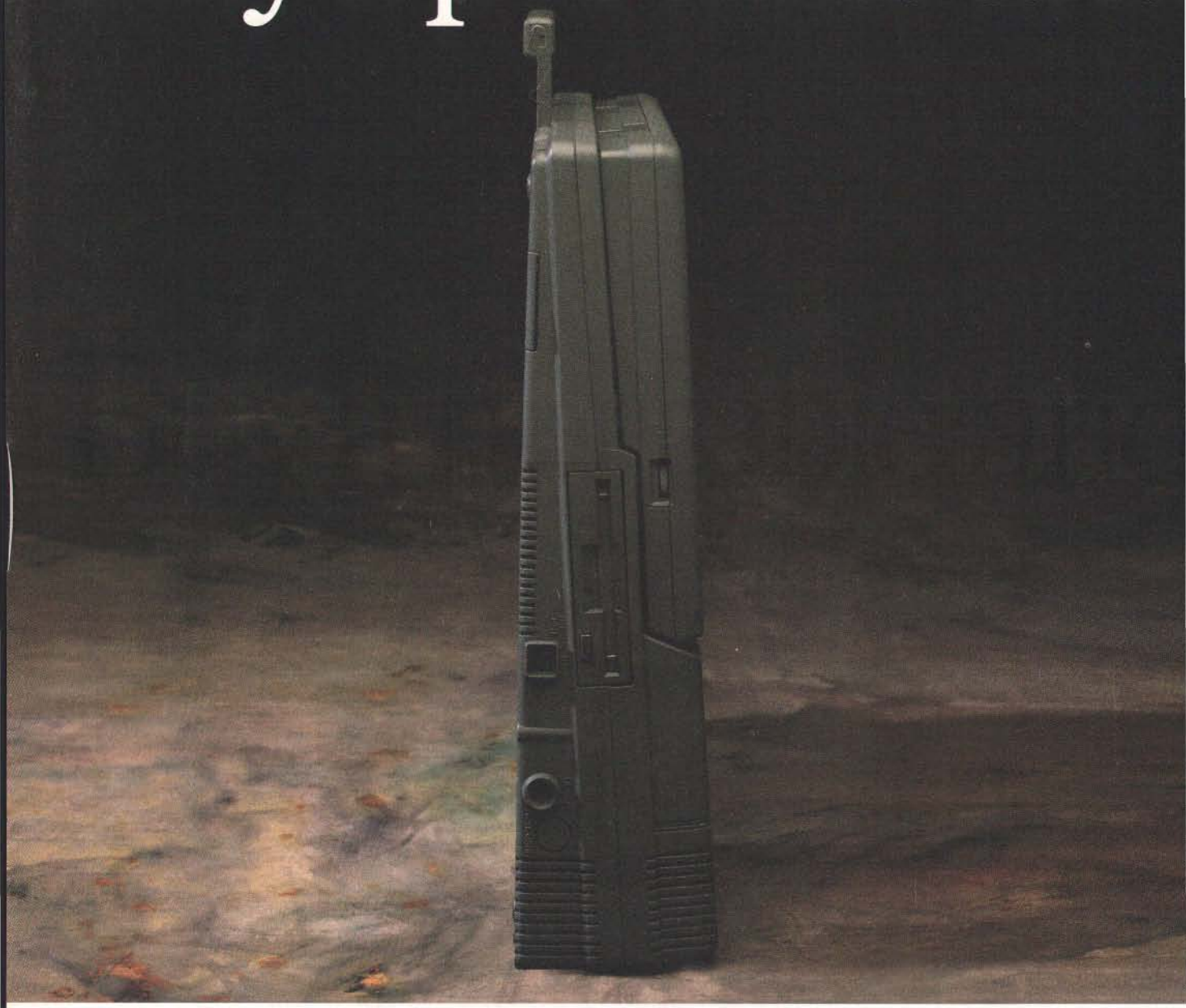
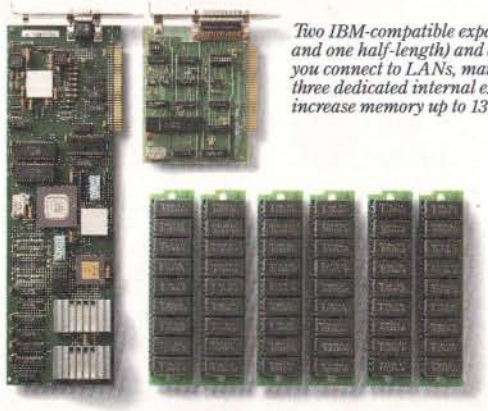
Buy a portable and



T3200SX: 170 pounds, 16MHz 386SX with 80387SX-16 coprocessor socket, 5 built-in ports, 40MB hard disk with 25msec access, 1MB RAM expandable to 13MB, gas plasma VGA display with 16 gray scales, 1.44MB 3½" diskette drive. IBM is a registered trademark of International Business Machines Corp. 386 is a trademark of Intel Corporation.

For more information call 1-800-457-7777.

$300
REBATE
With purchase of PageLaser6 laser printer and T3200SX. See dealer for details. Expires 5/31/90.



Two IBM-compatible expansion slots (one full-length and one half-length) and an internal modem slot let you connect to LANs, mainframes and more. Plus, three dedicated internal expansion slots let you increase memory up to 13MB.

get a desktop free.

At first glance what you see is a sleek, 17.0-pound portable.

But looks can be deceiving. Because with a powerful 386™SX microprocessor, 6 internal expansion slots and 5 built-in ports, our new T3200SX easily replaces desktop computers.

Which means it does everything a bulky desktop computer can do. Like networking, computer aided design, data bases or even complex spreadsheet analysis — anywhere you can plug into an AC outlet.

It has a built-in VGA gas plasma display system that lets you connect an external color monitor. And it can even accommodate an optional 101-key enhanced keyboard.

So you can take advantage of today's and tomorrow's most powerful new 386 applications, wherever you think best.

The new Toshiba T3200SX. Take it. See how far you can go.

In Touch with Tomorrow

TOSHIBA

Toshiba America Information Systems Inc., Computer Systems Division

Circle 314 on Reader Service Card (DEALERS: 315)

Pre-Press Software for the Mac

Color Access is a color separation program that helps you deal with the realities of color impurities and varying ink standards by letting you calibrate all output characterisics to yield consistent color.

You can calibrate the program (optimized to work with BarneyScan's 3510 or 4520 scanners) to work optimally on different types of output devices, paper, and ink and then set up defaults that are individualized for each customer or account. A scanning acquisition module called QuickScan lets you manage the size of a file at input, specifying its orientation from within Color Access.

Gallery, a program that works with Color Access, is a database for indexing and cataloging scanned images.

Color Access runs on the Mac II with a scanning device and any image-setting device that's PostScript compatible.
Price: Color Access, $1995; Gallery, $695; 3510 35mm scanning system, $9495; 4520 Multi-format Scanning System, $27,995.
Contact: BarneyScan Corp., 1125 Atlantic Ave., Alameda, CA 94501, (415) 521-3388.
Inquiry 1171.

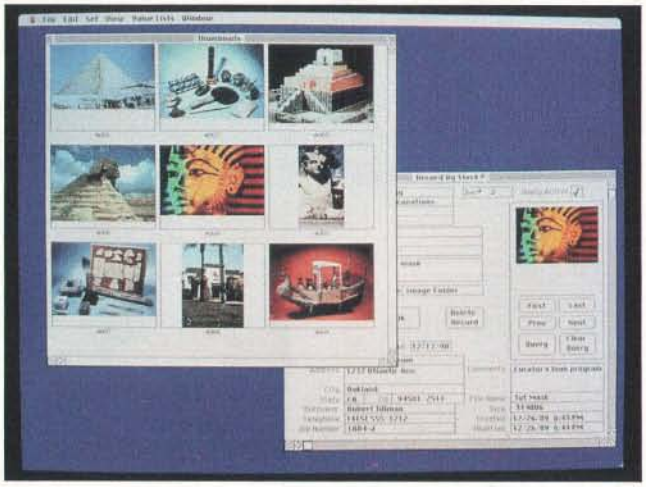
Desktop Publishing with No Jaggies

Unison World says that its Avagio Publishing System gives you PostScript quality without a PostScript printer. The program comes with scalable LaserJet outline fonts and 150 PostScript graphics. It's also compatible with LaserJet-format soft fonts from any vendor, and you can print them to any printer—from dot-matrix to Linotronic.

The WYSIWYG program includes four typefaces in nine styles (available from 6 to 500 points in increments of 1 point). Unison World says the program's font manipulation feature lets you compress or expand fonts while retaining the smooth edges—thus, no jaggies.

A Mingle feature lets you specify how objects, both text and graphics, mingle with each other when they overlap. For instance, you can define the black or white portions of any images as black, white, clear, or inverse.

Avagio will import PIC, PCX, TIFF, and Unison World graphics as well as ASCII, WordStar, and WordPerfect text files. It runs on the IBM PC with a 20-MB hard disk drive, 640K bytes of RAM, and a mouse.
Price: $299.95.
Contact: Unison World, 1321 Harbor Bay Pkwy., Alameda, CA 94501, (415) 748-6670.
Inquiry 1175.



Gallery, an image database program, relies on 8-bit color thumbnail images to achieve rapid image searches.

Rotate Text to the nth Degree with Quark

The latest version of QuarkXPress features free-floating measurement and page palettes that let you perform operations such as text kerning or picture rotation adjustment interactively, without having to access a menu command or open a dialog box. You can group text, graphical items, and rules for simultaneous manipulation, and a polygon tool allows you to wrap text around an arbitrary shape or image.

With QuarkXPress 3.0, you can rotate text and graphics in 0.001-degree increments. Quark says that it has improved the color separation abilities of the program by providing more sophisticated color trapping, allowing you to adjust color overlap manually.

Other features of the program include a document layout palette for arranging pages, a pasteboard that acts as an adjacent work area, and a library for frequently used items.

QuarkXPress 3.0 runs on the Mac II. The company recommends 2 MB of RAM.
Price: $795.
Contact: Quark, Inc., 300 South Jackson, Suite 100, Denver, CO 80209, (303) 934-2211.
Inquiry 1174.

Two Image-Capture Programs for Windows and PM

SymSoft has improved its HotShot Microsoft Windows and Presentation Manager image-capture program to let you save a full or partial screen, or a single window, to the clipboard or another file. HotShot Graphics 1.7 consists of three modules for capturing DOS, Windows, and PM screens, plus an image-editing module that runs under DOS or the DOS compatibility box.

The program can import and export PCX, TIFF, IMG, WPG, MSP, and MacPaint files, import GIF files, and export EPS files. You can also convert captured images to other formats.

The program requires 512K bytes of RAM.
Price: $249.
Contact: SymSoft Corp., 924 Incline Way, Call Box 5, Incline Village, NV 89450, (702) 832-4300.
Inquiry 1172.

Tiffany Plus, a Windows application that lets you capture any part or all of a Windows display, can conserve RAM by operating directly to disk files when exporting to another application. The program works with all Windows-compatible display adapters, according to the company. The program supports Microsoft Paint, Microsoft bit-map, TIFF, and PCX formats.

Tiffany Plus is not a TSR application and runs under all versions of Microsoft Windows 2.0 and higher.
Price: $89.
Contact: Anderson Consulting & Software, C-7-3 Cascade Dr., P.O. Box 40, North Bonneville, WA 98639, (800) 733-9633 or (509) 427-5335.
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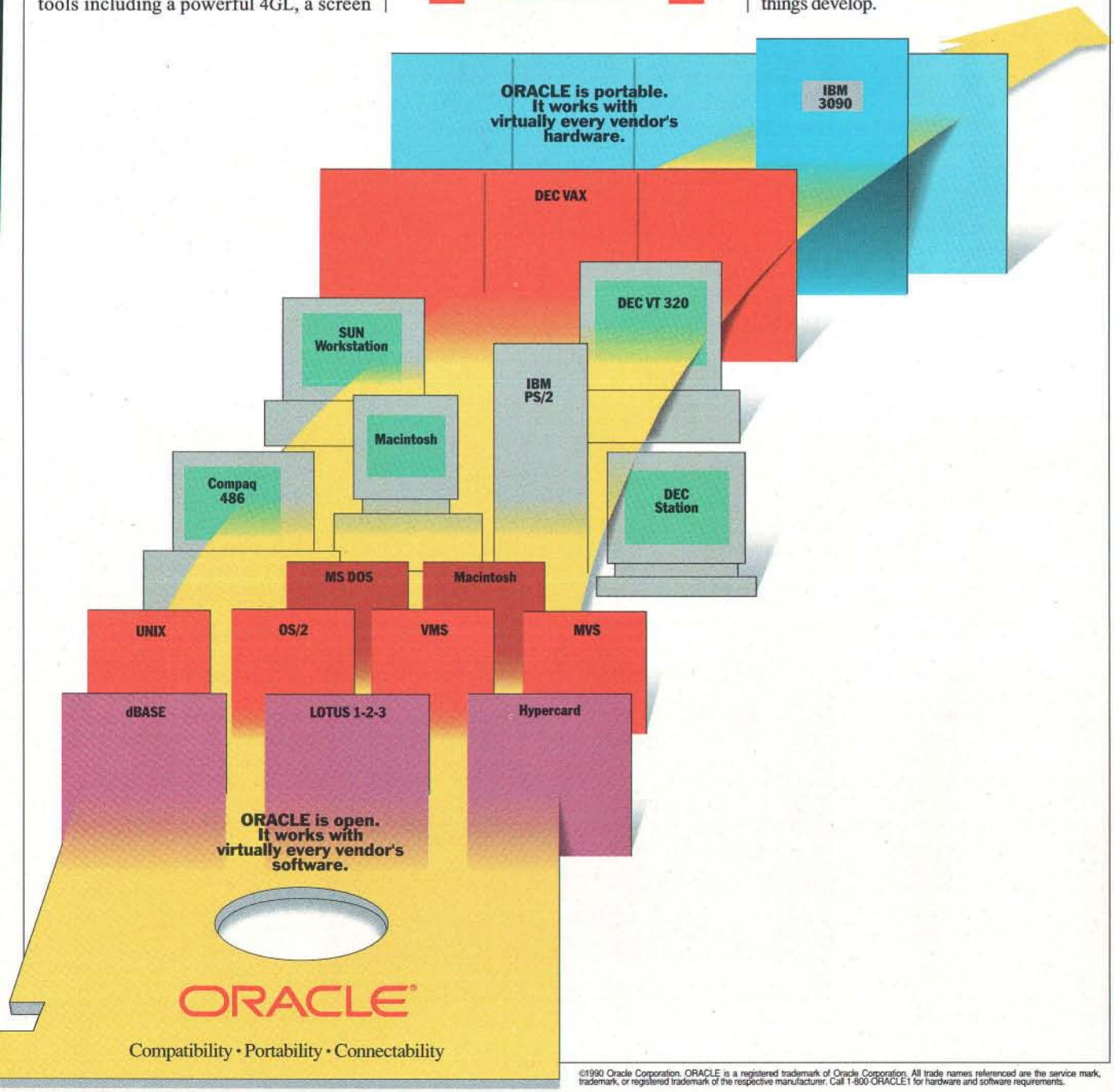

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Swanson Brings Ansys to the 286

Swanson Analysis, known for its finite-element analysis programs that run on mainframes and 386-based computers, now has versions of Ansys-PC for the IBM AT. The family consists of static and dynamic analysis, heat transfer analysis, and design optimization. PC Linear, the linear static and dynamic analysis program, features energy norm calculation for indicating where mesh refinement is needed for increased reliability.

All three programs are also available for 386-based PCs, plus a program for solid modeling and postprocessing.
Price: Prices start at $300 per month.
Contact: Swanson Analysis Systems, Inc., Johnson Rd, P.O. Box 65, Houston, PA 15342, (412) 746-3304.
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Vertex Design Systems' program for architects takes the headache out of an unglamorous but important facet of building design—detail drawings.

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A DBMS lets you search for details in several ways, including by product name, type, or location in the building. The program lets you preview in DOS a selected drawing instead of listing only the drawing's filename. This lets you make certain you've selected the correct drawing before you start working with it in AutoCAD. You can also modify the drawing in DOS and compile it on the fly before you pull it into AutoCAD.

The program uses components, not primitives such as circles and lines, as the basic building blocks for creating a detail. Instead of drawing the detail from scratch, you can assemble it by selecting a component, indicating its size, and snapping it into the drawing. Nested reference symbols let you jump between floor plans and other drawings and the referenced detail drawing.

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The Detailer runs on the IBM PC with 640K bytes of RAM and a hard disk drive.
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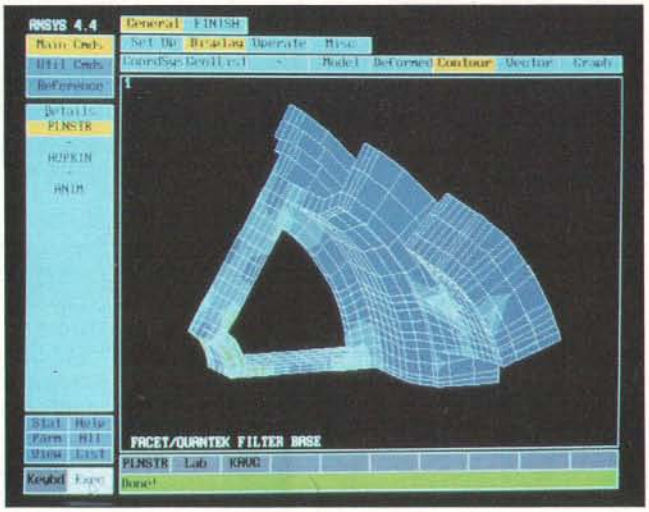

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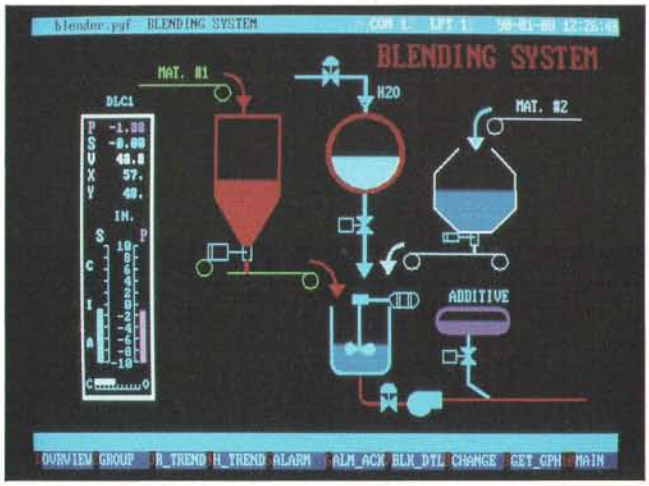

Aimax-Plus/Lab lets you construct a graphical representation of your lab.

Integrate Analysis and Graphics on the Mac

Systat, the statistical analysis program for the Macintosh, provides links between the data editor and the graph window, allowing you to instantly see the relationships between your data and graph. Systat 5.0 can plot standard graphs and plots, plus contour plots, triangular coordinate plots, and others.

With the program's scatterplot brushing tool, you can click on any point in a graph and display its case or click a case and see its point.

The program runs on a Mac with 4 MB of RAM.
Price: $795.
Contact: Systat, Inc., 1800 Sherman Ave., Evanston, IL 60201, (708) 864-5670.
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TA Engineering, a developer of DOS-based factory automation software, has released a program for monitoring lab instruments 24 hours a day, seven days a week.

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Aimax-Plus/Lab runs on the IBM AT with 640K bytes of RAM, a hard disk drive, and a PC-bus I/O card.
Price: $995.
Contact: TA Engineering, 1605 School St., P.O. Box 186, Moraga, CA 94556, (415) 376-8500.
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A sophisticated environment for quick and dirty programming

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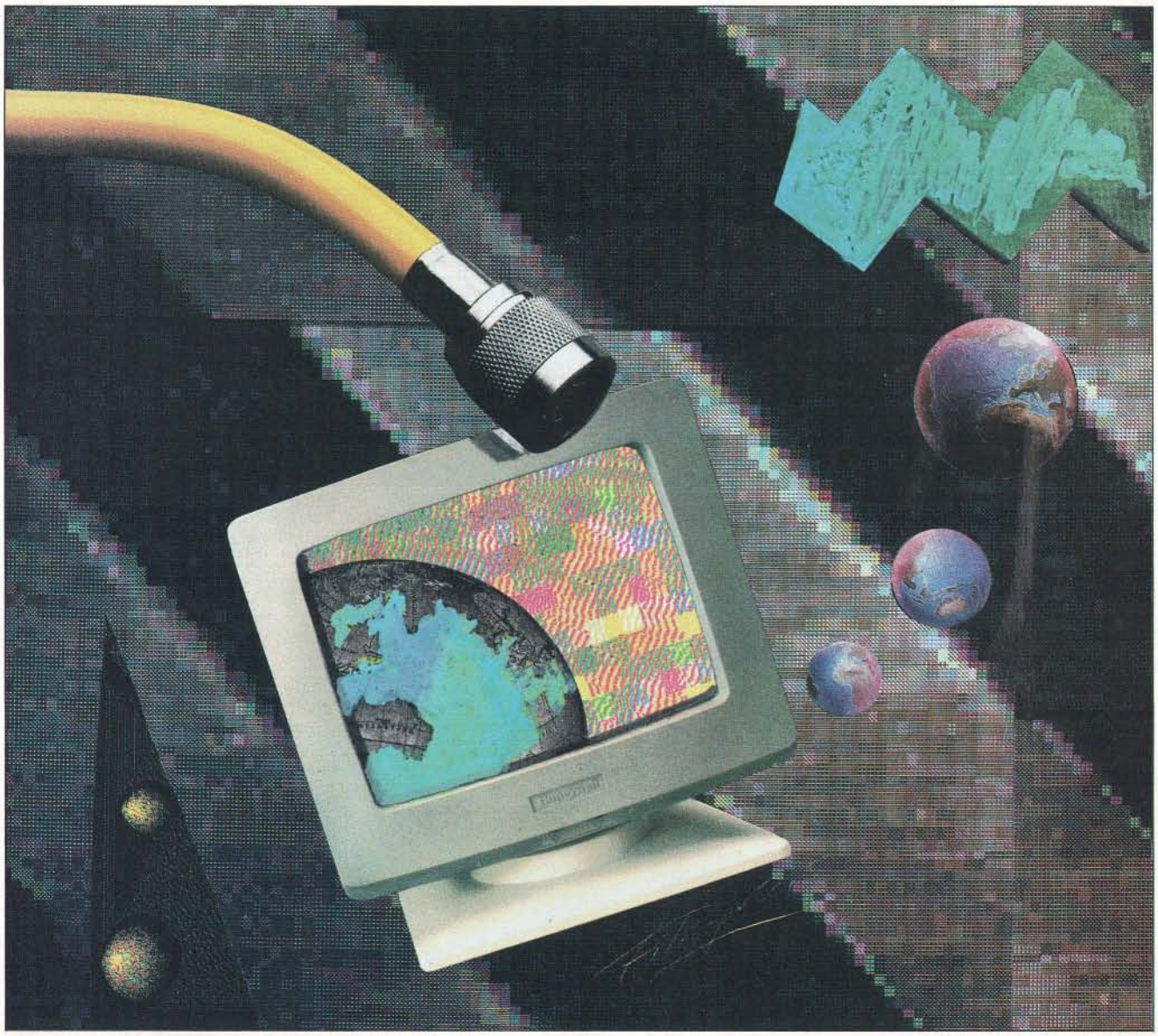

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The PCL Language

Dick Pountain

A sophisticated environment for quick and dirty programming

An interpreted language that is as fast as compiled Turbo Pascal? Impossible? I thought so too until I tried PCL. Not only is it fast, but it's a TSR program that pops up when you need it, and it has ultra-high-level commands for matrix math, sorting, screen handling, file operations, and serial communications. All this makes for very short programs packed with power and speed. There is even a version for OS/2 that handles full-threaded multitasking. With all this, you might expect PCL to have some weird avant-garde syntax and be difficult to learn. Wrong again. It looks very much like simple and neat BASIC.

The Interpreter

PCL comes as a single executable file of some 120K bytes, remarkable nowadays when you expect language systems to fill five or six subdirectories. When you first invoke it (by entering "PCL"), it displays a title screen bearing the sizes of its workspaces. One difference from BASIC emerges immediately: PCL is not limited to only one 64K-byte segment; it can use the whole of available memory. The default workspace is 90K bytes, but you can set it to anywhere between 12K and 576K bytes (it leaves 64K bytes for DOS).

When you press any key from the start-up screen, PCL drops you into a seriously minimal environment—just a blank screen with a command line at the bottom. Similarly to BASIC, PCL immediately executes any command that you enter on this line. The blank upper part of the screen can be used as a simple text editor for programs up to 25 lines long, but it is actually the default area for PCL program output. I never used this built-in editor, finding it far more convenient to use a pop-up external editor, namely the SideKick Plus Notepad. Conversely, you can pop up resident PCL over your favorite editor.

To run a program, you just type RUN *myprog* (where *myprog* is the name of the file holding the source code): The extension automatically defaults to .PCL; the file then loads, compiles into memory, and runs, all in a single rapid operation. For very small programs, you can type LOAD *myprog* to load the source into the internal editor, and then type RUN. In either case, to run the program again you need only type RUN, as the machine code remains in memory until you clear it by RUNning a different program or typing NEW.

Alternatively, you can start a PCL program from the command line with any sequence of PCL commands. So you could type PCL RUN *myprog* from DOS. A third option is to create a file called PROFILE.PCL containing any sequence of PCL commands, which will be automatically executed when PCL loads. Typing PCL INSTALL makes the PCL interpreter memory-resident, and it pops up when you press the left and right Shift keys simultaneously. (This assignment clashes with the default hot keys for SideKick and cannot be altered; I had to alter SideKick instead.)

Language Overview

The minimalism of PCL's design carries through into its syntax. You can specify simple statements composed of commands, expressions, or directives simply by typing them one-to-a-line in the source file, just like a DOS batch file.

You must enclose multiple statements in a block that starts with DO and ends with ENDDO; the statements can be placed one-to-a-line or all on the same line separated by semicolons. PCL has no reserved words, as it can always distinguish user identifiers (i.e., variable and procedure names) from built-in commands with the same name (e.g., RUN) by their context. User identifiers can be of any length up to 240 characters and are not case-sensitive.

PCL recognizes just four data types: INTEGER, FLOAT, CHAR, and FILE. It's not a strongly typed language. Type conversions are performed automatically during assignment when and where they make sense (similar to some versions of BASIC). For example,

```
INTEGER X; X = "12"
```

will assign the value 12 to X, the type of the string being converted to that of the target variable on the left side. The default condition is that variables do not need to be declared (as in BASICA), but they inherit a default type, which at start-up is FLOAT. You can change this default type using the directive DEFAULT *type*. Issuing the command STRICT makes PCL enforce the declaration of all variables (I preferred to work with this option on all the time).

PCL supports arrays of all the types, of one or two (but no more) dimensions. You can redimension an array at run time using DIM as long as you don't increase its total memory requirement. Strings are treated as variables of type CHAR, and their maximum length can be declared individually using array syntax (e.g., `CHAR X[30]`) or collectively as in `CHAR 12, Str1, Str2, Str3`. If not declared, the length defaults to 120. You must declare an array of strings as a two-dimensional array of CHAR.

The control structures of PCL are equally minimal. It supports only two kinds of loops. The first is obtained by putting an index after the DO of a DO block, so that

continued

Listing 1: *An example of how to do input for a payroll program.*

```
GROUP PayRecord[9]
CHAR Pmt1,Pmt2,Pmt3,Name[20]
INTEGER Employees,EmployNum
FLOAT Pos1,Pos2,Pos3,Pay

PayRecord = Pos1+Pmt1+Name+Pos2+Pmt2+EmployNum+Pos3+Pmt3+Pay
Pos1= MPARM 1,2,20,6;          Pmt1 = 'Name? '
Pos2= MPARM 4,2,8,6,ValidNum;  Pmt2 = 'Employee Number? '
Pos3= MPARM 7,2,12,5,ValidPay; Pmt3 = 'Pay? '

PROMPT 'How many employees? ',Employees
DO Employees
 MPROMPT PayRecord
 WRITE PayFile, PayRecord
ENDDO
```

Benchmarks Comparing PCL to Turbo Pascal

Even though it is an interpreted language, PCL is significantly faster than Turbo Pascal on all the tests except the Sieve.

Benchmark	Sieve	BYTE1	BYTE3	Savage	Screen Write
PCL 3.40	3.1	0.6	1.4	123.5	66
Turbo Pascal 5.5	1.15	1.4	1.9	110 real 146 double	81

All times are in seconds. Turbo Screen Write with DirectVideo := True.

```
DO 10
  ? "Hello world!"
ENDDO
```

prints the infamous phrase 10 times. A DO loop does not decrement its counter, so you can't use it within the loop; you must maintain your own explicit loop count (which some authorities would say is not a bad thing):

```
 I = 0;
 DO X
   statements
 I = I + 1
ENDDO
```

The second kind of loop is a conditional loop using WHILE, as in

```
 WHILE K <= 8190 THEN DO
   Flags[K] = 0
 K = K + Prime
ENDDO
```

There are also two kinds of conditional branches: IF...THEN...ELSE, and BRANCH *indexvar*, *label1*, *label2*..., which is a low-level kind of CASE statement. Simple as these constructs are, they are fully structured, so, although PCL provides GOTO *label*, fastidious programmers will not need to use it. On the other hand, you can make a quick exit from a loop with LEAVE. PCL needs no GOSUB, as it employs named procedures with parameters, declared using PROC...ENDPROC. Procedures can have local variables. Regrettably, there are no user-defined functions; to return a value from a PROC, you'd have to use parameters for output. This is easily done, since all parameters are passed by reference rather than value.

PCL has an unorthodox but attractive way with files. A FILE variable behaves in many respects like a string variable. You assign a legal DOS filename to it, and then you can read or write from it immediately. PCL automatically opens and closes files, which cuts out a lot of messy code. The following is legal in PCL:

```
FILE MyFile
MyFile = "C:\PCL\MYFILE.DOC"
WRITE MyFile,"Hello file!"
```

You can do either sequential or random file access (accomplished by moving the file pointer FPTR). PCL supports three types of ASCII and two types of binary file formats, which handle line ends and numeric formats in different ways. File errors are reported by the ERR function. Error number 1 is end-of-file:

```
IF ERR MyFile = 1 THEN LEAVE
```

The powerful DOS file-handling commands all know how to expand wild cards, removing yet more of the mess that programs often fill up with. PCL supports file locking, so you can write multiuser and network programs for use with the DOS SHARE facility.

Perhaps the most original feature of PCL's design is the *group*. A group is a dynamic data structure, somewhere between a record and the tuples used in some languages. It consists of several named variables joined together. You must declare the maximum number of members a group can have, but you can add or subtract actual members at run time:

```
GROUP G[6]      ! This group can have
                ! up to 6 members.
CHAR 20,A,B,C   ! Three string
                ! variables
INTEGER D,E
FLOAT F

A = "dog"
D = 12
....
G = A+B+C
G = G+D+E+F
G = G-C         ! G is now A+B+D+E+F
```

You can add or remove members at will, either by name or by index (G[2] means the second member of G—B in the above example). You can compare groups; they are equal only if the number, names, and order of their members are equal. The SHOW command displays the members' names, while the print command (?) displays their current contents. You can read and write groups to a file in one lump, just like records.

PCL's groups exist at a level of abstraction lower than that of the Pascal record type or C structure. G is not a type but an instance—that is, a single variable. This makes groups less powerful but easier for a beginner to handle than records.

To some extent, groups can fulfill the role of lists (i.e., they can hold mixed types and be extended at run time), but the lack of abstraction hinders full list processing, for every node has to have a known, unique name. I couldn't find an easy way to implement classic lists or trees using the group. The powerful EXECUTE feature possibly offers a way.

PCL permits meta-programming by allowing you to access the interpreter/compiler at run time; EXECUTE *String* compiles and executes its argument (which may be a constant or a variable) as a string of PCL commands. The related COMPILE *String* just compiles the

continued

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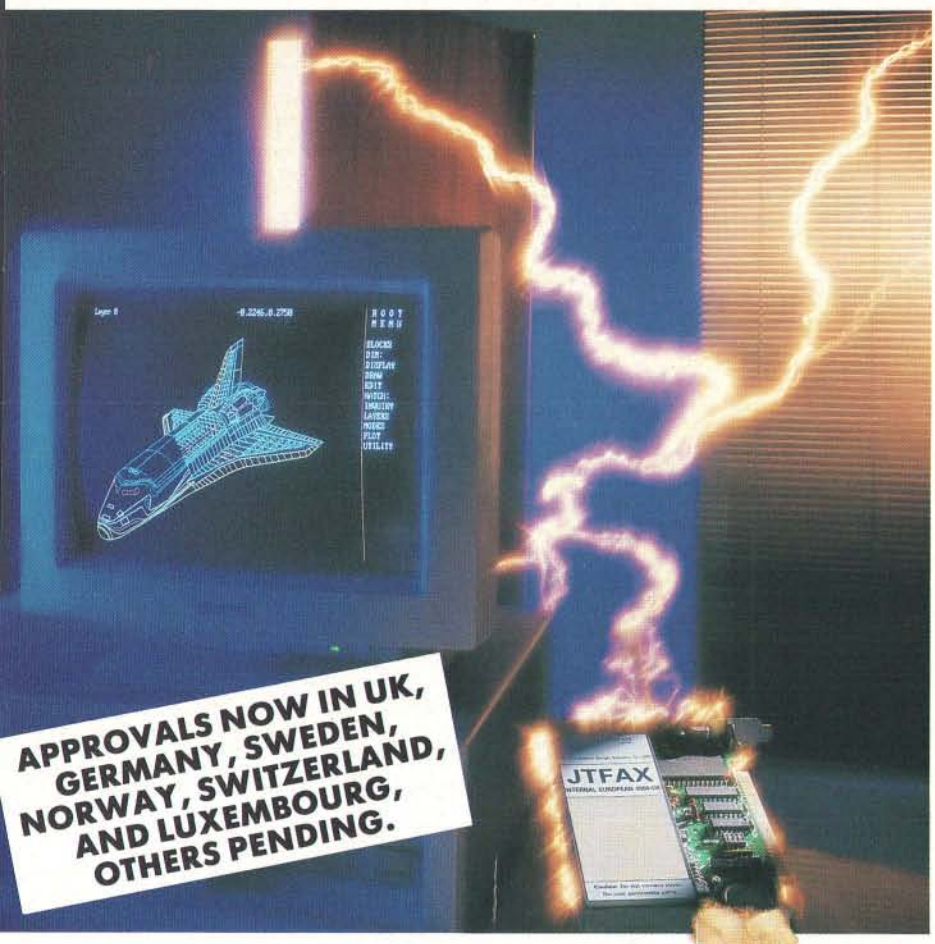

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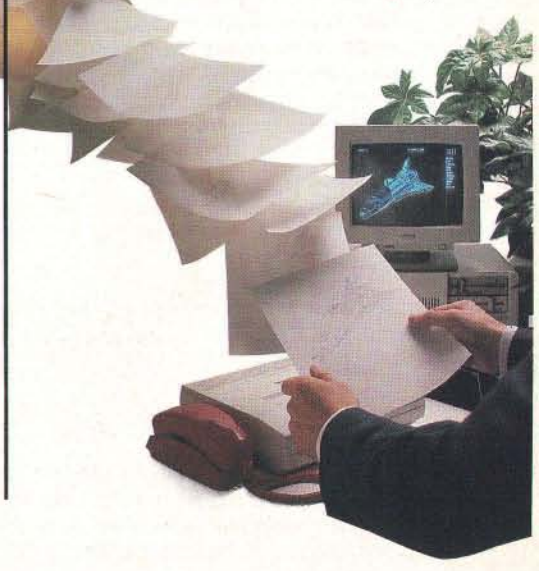

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Listing 2: *The PCL performance tests that I used for the table.*

```
! Sieve of Eratosthenes

INTEGER I,K,M,Size,Count,Prime,Flags
[8190]

Size = 8190
CLS
? "10 iterations"; SKIP 1

DO 10
    Count = 0
    I = 0
    DO Size
      Flags[I] = 1
   INC I
  ENDDO

  I = 0
  DO Size
   IF Flags[I] = 1 THEN DO
      Prime = I + I + 3
      K = I + Prime
      WHILE K <= Size THEN DO
       Flags[K] = 0
       K = K + Prime
      ENDDO
      INC Count
    ENDDO
    INC I
  ENDDO

ENDDO
? Count," primes found"


! Byte1 tests sequential write to disk

INTEGER Iterations
CHAR A[32],B[128]
FILE TestFile

CREATE "C:PCLTEST.DAT"
TestFile = "C:PCLTEST.DAT",A0

A="12345678123456781234567812345678"
B=A+A+A+A

Iterations = 512
DO Iterations
 WRITE TestFile,B
ENDDO

? "done"


! Byte3 tests floating-point multiply
  and divide.

DECIMALS 16
INTEGER NR

NR=5000
A=2.71828; B=3.14159
C=1
DO NR
 C=C*A
 C=C*B
 C=C/A
 C=C/B
ENDDO
? "Done; Error = ", C-1


! Savage tests transcendental functions

INTEGER I
FLOAT A

CLS
? "Start"; SKIP
A = 1.0
DO 25000
 A = tan(atan(exp(ln(sqr(A*A)))))+1.0
ENDDO
? "A= ",A


! ScreenTest tests text writing to screen

DO 10000
 ? 'ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghi
   jklmnopqrstuvwxyz'
```

string for syntax checking and must be followed by an EXECUTE. A program can trap errors that occur after a COMPILE. EXECUTE gives you access to the full power of PCL's internal parser and expression evaluator. This fragment, for example, adds a full-blown scientific calculator to your program:

```
CHAR InStr[80]

WHILE Instr<> "QUIT" THEN DO
  InStr = ""
  PROMPT ': ',InStr
  EXECUTE '? '+InStr ! Pass off the
                     ! string as a
                     ! line of PCL
  WAIT; CLS;
ENDDO
```

I'm greatly in favor of this sort of programming; nothing is more boring and depressing than having to write an arithmetic expression evaluator knowing full well that a perfectly good one exists inside your compiler.

One area of PCL's design with which I am less in agreement is the run-time error handling. In an attempt to make things less frustrating for beginners, PCL dispenses with most classes of run-time error by offering "sensible" defaults. For example, dividing by zero is not an error; it returns the largest INTEGER or FLOAT. Similarly, if you try to index beyond the end of an array, PCL will just return the last element and keep running. This approach makes impatient programmers happy, but it is counterproductive in the long term; if a program is broken, it should stop and tell you so.

PCL has no support for writing very large programs—that is, no equivalent of modules or units. But it does have an INCLUDE for source files and CHAIN, which invokes a new program from disk and passes to it the values and names of all global variables from the current program.

One limitation that will vex Pascal and C programmers is that although PCL allows recursive procedure calls, it does not allocate local variables on a stack, so their values are not preserved on return. This spoils most of the attraction of recursive solutions. However, PCL is already disqualified for system or AI programming for many reasons, so this will not matter much to typical users.

PCL Commands

The simplicity of PCL's syntax might lead you to dismiss it as a toy language, but its multiplicity of powerful commands will soon rid you of that illusion. Like a good BASIC (or like Turbo Pascal), PCL eschews any pretense at portability or universality in favor of doing one thing well—namely, programming the IBM PC. There is one caveat: PCL does not support graphics. In the areas of text manipulation, file handling, math, serial communications, and transaction processing, it has commands that humble those of BASICA or Turbo Pascal and that can cut your programming time substantially.

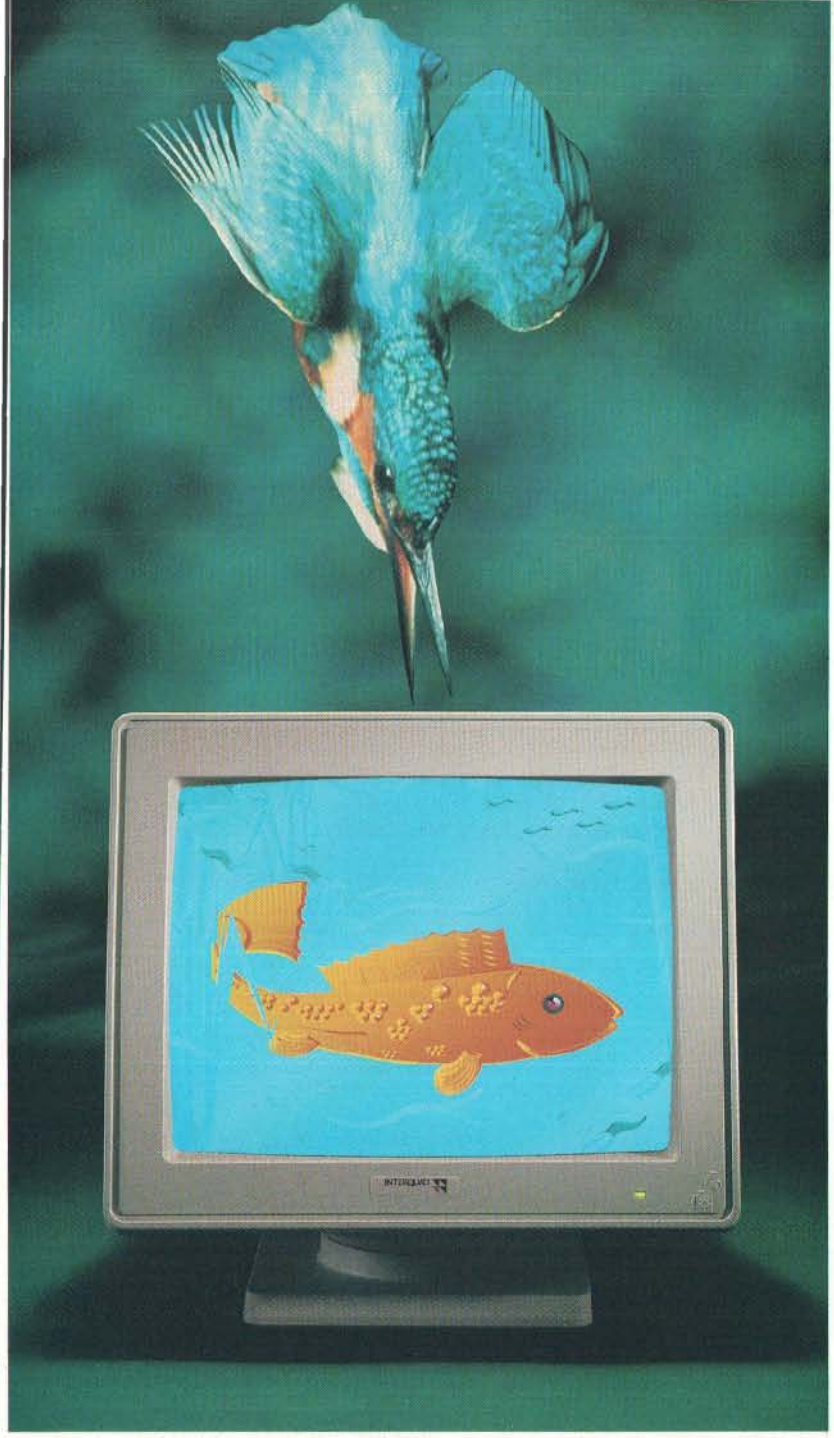
PCL supports an 80x87 floating-point coprocessor if one is installed. Integers are single-precision (2 bytes), ranging up to only 65535, but floats are double-precision (8 bytes) and lie in the range e^{-38} to e^{38} with 16-digit accuracy. PCL has all the usual transcendental functions—LOG, SIN, and so forth—including all inverse trigonometric functions. Then there are more-unusual ones like HYPO x, y, which calculates the hypotenuse of a triangle; P x, y, which calculates permutations; FAC x for factorial; and even PRIME x, which returns the nearest prime to x (it runs 10 times faster than the Sieve).

The powerful time and date commands reflect the language designer's interest in astronomy; Julian and Gregorian dates are supported. There is a whole group of functions for calculating time and date differences and formatting them in different ways.

PCL also offers a plethora of array arithmetic commands. You can apply ADD, SUB, MUL, or DIV to whole columns and rows of arrays of integer or float, and you can select subsets of an array to work on. These are commands, not functions; they return no value, but they alter the actual array contents. There is also a PROD command that calculates the inner product for two arrays. Various MIN and MAX functions locate the maximum and minimum elements of arays, and SWAP exchanges elements. You can write spreadsheet programs very quickly with these tools.

Three other array commands that deserve attention are SORT, ISORT, and ORDER. SORT *Array* sorts an array of

continued



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any type, in situ. ISORT *Array1 Array2* creates a sorted index to Array1 in the integer array, Array2, while ORDER will reorder the actual data in Array1 to match the index order.

Text manipulation is supported equally lavishly. In addition to all the usual functions for searching, replacing, and extracting substrings, there is a parsing command that works in a novel way. The statement TABLE *S1,S2* splits the string S1 into tokens, using S2 as a delimiter, and stores the tokens in an internal array. TABLE is a function that returns as its value the number of tokens thus parsed. You cannot manipulate the TABLE array directly, but instead you use the function TABITEM *n*, which returns the *n*th element. This fragment reads in a line from a text file and prints it out as a list of words:

```
READ InputFile, LineText
Words = TABLE LineText,' '
I = 1
DO Words
  ? TABITEM I; SKIP
  INC I
ENDDO
```

The function TRANSLATE *S1,S2,S3* maps characters from the alphabet S1 (a single string) into those from alphabet S2 wherever they occur in string S3. There are also several commands for dealing with leading, trailing, and embedded spaces and control characters in strings.

Keyboard handling is perhaps the most impressive aspect of PCL. Simple input is performed using the BASIC-like INPUT and PROMPT commands, and WAIT *x* pauses until key *x* is pressed (without an *x* it defaults to any key). The tricky stuff comes in with MPROMPT (for multiple PROMPT), which allows you to have up to 85 separate fields on the screen from a single command, complete with their own prompt strings. You can attach to each field a PROC of your own to validate the input into that field. This makes the process of writing data-processing front ends a cinch.

MPROMPT employs a group with the special structure of three members for each screen field, and the function MPARM is used to store field position information into members of this group. A single MPROMPT then prompts the user to complete a screen "form," which fills the group with data. Listing 1 shows how you might approach developing a payroll program.

It isn't compulsory to write the whole of the `PayRecord` group to disk; you could subtract the `Pos` and `Pmt` members if you wished. You can write the definition of a group's structure to a file in text form and then EXECUTE the description when it is read back, which lets you create data dictionaries very easily.

Among many other powerful keyboard commands is KBPROC *p*, which executes the user procedure *p* whenever the main program is waiting for keyboard input. Since interactive programs spend most of their time waiting for you to type a character, you can exploit KBPROC to multitask in a simple, nonpreemptive way. The only formal restriction on *p* is that it cannot take parameters, but if you make it do too much work, the keyboard response will suffer noticeably.

PCL screen handling is text-mode-only, but it provides full overlapping text windows with the ability to save and restore a window's contents with single

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commands. PCL also supports video page switching.

The level of serial-communications support built into PCL is higher than that of many specialist libraries I've seen. All communication is interrupt-driven and is performed as a background task. The basic commands are RS232, to set the port parameters; SEND and RECEIVE, which work on whole strings rather than single characters; and TERMINAL, a teletype terminal emulator, complete with file capture to any device or file. PCL handles all buffering invisibly, but there are advanced commands for those who need to delve into lower levels.

As if all these high-level operations were not enough, PCL has 17 commands for bit-level logical, shift, and test operations; it permits entry of hexadecimal and binary number representations; and it has primitives called H and B that print numbers as hexadecimal or binary strings. There are machine-level instructions to call DOS and BIOS interrupts and to examine and manipulate CPU registers. And there are machine code commands (e.g., ADD, ADC, CMP, JZ) that, while not constituting a full assembler, enable you to write assembler-like routines. As an interactive system for probing hardware, PCL rivals Forth.

Performance

I was unable to use the new BYTE benchmarks, since they are written in Small-C. I fell back on the Sieve, the old BYTE BASIC disk and floating-point benchmarks, the Savage (to test transcendental functions), and a benchmark I made up to approximate the text screen-writing test in the new suite (see listing 1). All the tests were run on a 16-MHz Minstrel 386SX workstation; I had to increase the iterations tenfold on the Sieve, BYTE1, and BYTE3 to get sensible timings.

The results were highly illuminating, especially when compared with those of Turbo Pascal: PCL is significantly faster than Turbo on all the tests except the Sieve. The results are summarized in the table, and the source code is in listing 2. PCL's performance on the Savage is especially impressive, with an error factor of 0.00006 over 25,000 iterations; when comparing the timings, remember that PCL's floating-point operations are double-precision.

If you think of PCL as an interpreted language, its performance is hard to believe. In truth, PCL is a fully compiled language. It differs from compiled languages like Pascal or C only in that it does not create linked .EXE files but rather runs the fully compiled machine code program from its own interactive shell. This gives it all the capabilities of an interpreter but with few of the usual performance overheads.

The developer's version of PCL can save the compiled code of a program and then load and run it without further compilation using the XRUN command. This version also lets you distribute PCL programs in encrypted source form by providing a run-time module, PCLR.COM. The advantage of distributing encrypted source code rather than compiled code is that the user can upgrade to new versions of PCL and still be able to run the code.

Directions

PCL is the brainchild of one person, Wolfgang Lilienfeld, 20 years a programmer, who used to design airline booking systems at IBM. He intended

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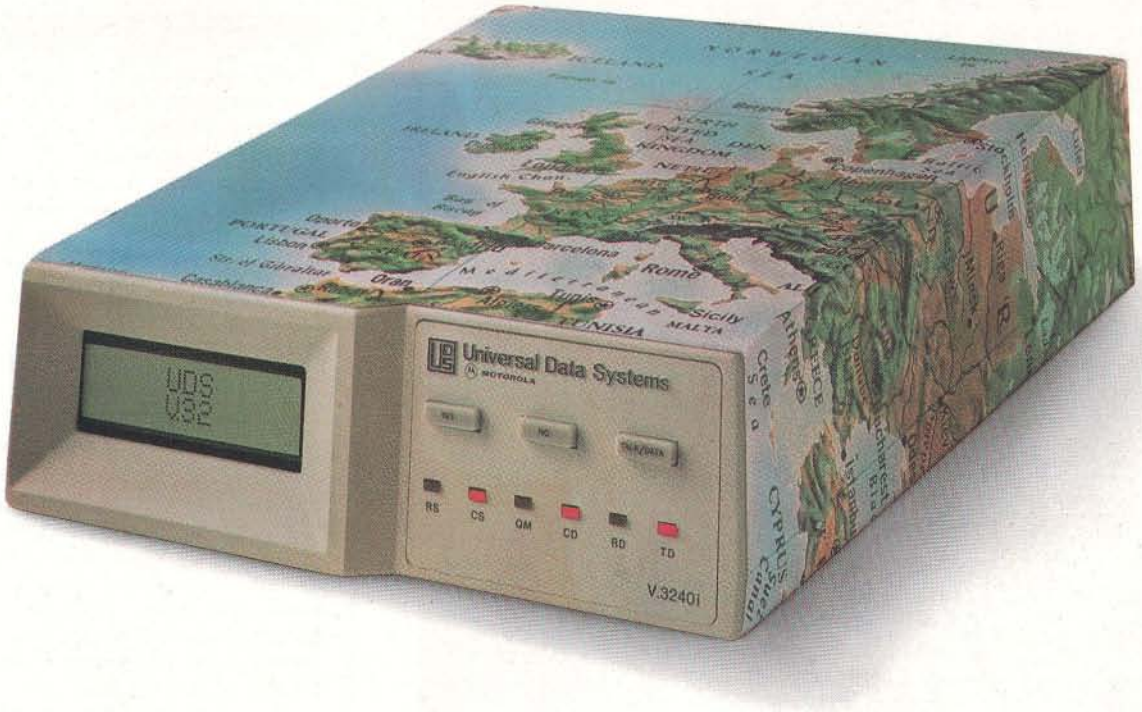

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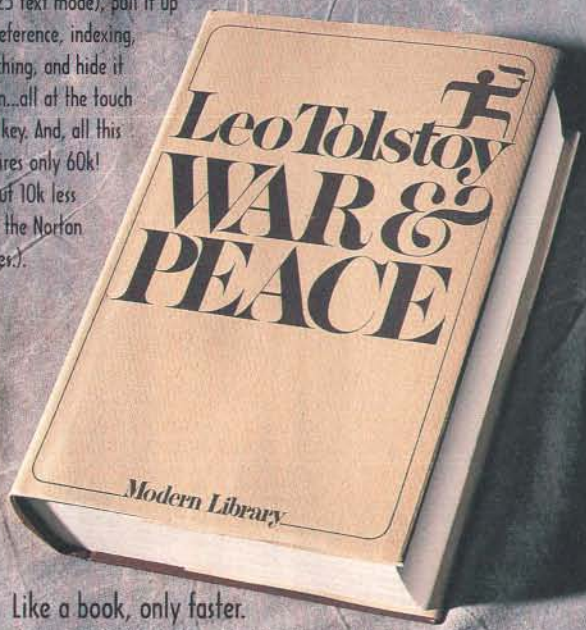

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PCL originally as a database language to rival dBASE, but it grew into a general-purpose language.

PCL is not going to rival C as a language for developing commercial applications (C is becoming the COBOL of our times). Like BASIC and cult languages such as APL and Forth, it will appeal more to those people who need to write their own programs, people whose needs are too far from the mainstream to make do with off-the-shelf solutions.

After some initial suspicion, I came to like PCL a lot, although it aggravated a certain schizophrenia I have about programming: One of my personalities is a firm convert to the Pascal/Modula philosophy of strong typing and rigor. The other personality learned programming on a BASIC interpreter and went on to Forth and Lisp; this aspect likes interactive environments and powerful semantics that let me improvise as I go.

PCL is very much in the latter camp. It's easy to learn, concise in expression, and fast in both execution and program development time. It's also closer to the mainstream than Forth, APL, or Lisp; a BASIC or Pascal programmer will pick it up in a day. In short, PCL is a pragmatist's language; it incorporates no great new theoretical principles, but it eats up small, quick programming tasks in a very satisfying way.

If you need to write your own specialized programs, PCL is worth investigating, especially at its low price. Its superb floating-point performance and math functions make it suitable for laboratory work (although the lack of graphics could be a drawback), while its low-level control brings process control and data logging within its compass, as well as commercial data processing. ■

Dick Pountain is a BYTE consulting editor, technical author, and software consultant living in London, England. You can contact him on BIX as "dickp."

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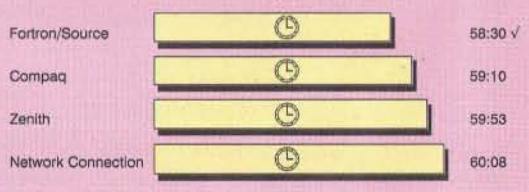

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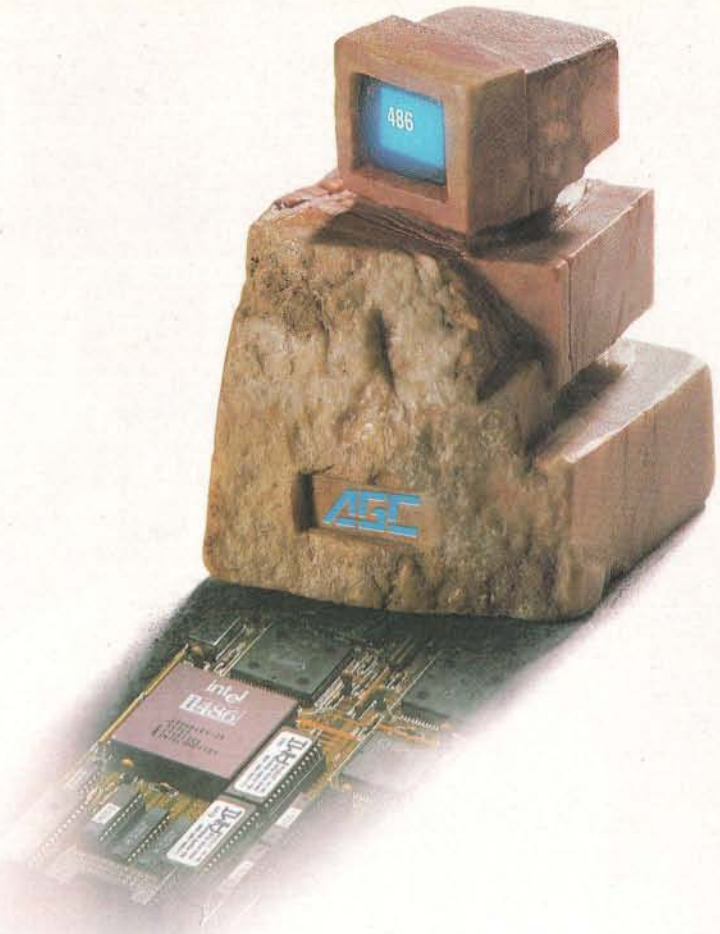

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BYTE editors' hands-on views of new and developing products

HM Systems' New Minstrel 486 Workstation

In the November 1989 International section of BYTE, I discussed HM Systems' Minstrel with a 386SX CPU card. Since then, HM Systems has shipped an i486 version of the machine (it was one of the first U.K. firms to ship an i486-based system). To recapitulate briefly, the **Minstrel** is a small-footprint, IBM PC compatible that uses a passive backplane, meaning that the CPU and memory are contained on a plug-in card that you can change.

The new 486 CPU card is a complete redesign, incorporating wholly different chip sets from the 386SX version. The full-length card contains 8 MB of main memory in eight single in-line memory module packages and about 30 other chips, dominated by the huge, ceramic-packaged i486, which runs at 25 MHz. There is, of course, no empty coprocessor socket, as the i486 has an on-chip floating-point processor. The board design employs no external processor cache memory and relies entirely on the i486's on-chip cache; however, the memory is interleaved in two banks to avoid wait states.

The i486 chip in the review machine was a B5 part (i.e., fifth revision) and still contains one of the obscure bugs in floating-point error handling that prevented Intel from shipping the chips last year. But HM Systems will, if requested, offer a free upgrade to the debugged chip when it becomes available. Intel's notes claim that the bug will be very rarely encountered in application code, and in particular that AutoCAD and Lotus products are unaffected as they do not use unmasked floating-point errors. I didn't encounter any errors as a result of this bug on any of the software I ran during this test.

Full PC emulation is provided by the G2 three-chip set, working with a ROM BIOS from Quadtel. The G2 chip set uses programmable logic to configure bus, I/O, and memory timing and BIOS shadowing, all of which you can change through software. The motherboard also features a Chips & Technologies 452 VGA chip set and 256K bytes of video memory on a small piggyback card. The VGA chip set proved to be fully register compatible with the IBM VGA, unlike the 451 VGA chip set on the older 386SX card; I tested this by running the nonstandard "tweaked" modes in the public domain fractal program FRACTINT. The 452 VGA is also faster than the 451 and capable of higher resolution, up to 1024 by 768 pixels on a suitable monitor.

THE FACTS

Minstrel
486 Workstation
£7950, with 8 MB of memory, a 3½-inch 1.44-MB floppy disk drive, a 44-MB hard disk drive with Konan Tentime caching controller, and a color VGA monitor.

HM Systems plc.
Minstrel House
220 The Vale
London NW11 8HZ
UK
44-1-209-0911
Inquiry 883.

The rest of the machine was identical to the 386SX Minstrel discussed in November, and it behaved in exactly the same way, apart from some subtle differences with color programs due to its better VGA compatibility. My main interest in covering this further was to see just how much faster the i486 really is, given the rare opportunity of an otherwise identical environment. I ran the new BYTE benchmarks on the machine, and they showed a mix of integer and string operations—the i486 is around five times faster than the original IBM AT and around twice as fast as the 386SX Minstrel. On floating-point calculations, the i486 really leaps ahead to 20 times faster than an AT with an 80287 CPU; on disk access, it's six times faster. The last result is more than twice as fast as the 386SX machine fitted with the same Konan Tentime caching disk drive controller, but inspection of the individual figures shows that this is due to the vanishingly small Seek results, and I am skeptical that such an increase would be seen in everyday applications. The video timings are twice as fast as the AT's or the 386SX Minstrel's. HM Systems told me how to alter the bus timing for even faster operation, by programming the logic arrays using DEBUG.

continued

This produced a 10 percent to 20 percent speedup of some disk operations but caused system crashes in certain VGA graphics modes, so I abandoned the exercise.

On word processing and similar tasks, I found little advantage compared to the 386SX because these operations are effectively instantaneous on both machines. But given a task that uses floating-point arithmetic, the difference becomes stunning. The improved graphics drawing speed is also appreciable.

The moral is that the Minstrel 486 is really only a cost-effective purchase if you are going to do a lot of floating-point math and graphics, so users of large spreadsheets, AutoCAD, and similar programs should find this 8-MB workstation very satisfactory indeed, even at its steep price. HM Systems plans to launch an entry-level version with only 2 MB of memory for a price closer to £4000.

—Dick Pountain

PC-to-PC File Transfers Made Easy

East Coast Software's **Trax** is not just another general-purpose communications program—it is a file transfer program designed to make remote file transfer as easy and nontechnical as sending a fax, and it largely succeeds thanks to an excellent user interface design.

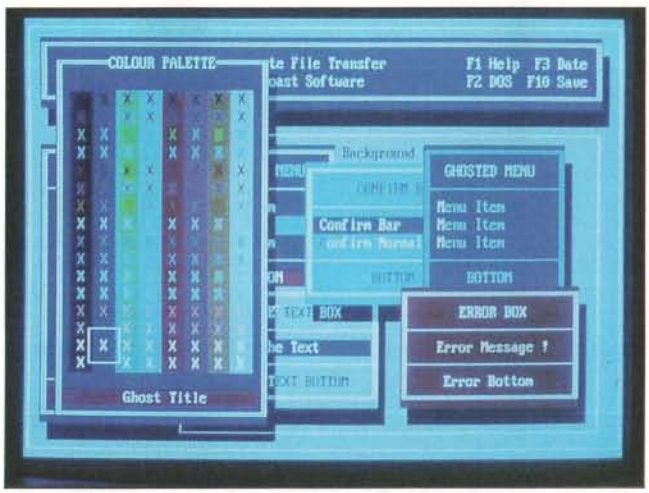
The program comes on a single disk (both 5¼- and 3½-inch floppy disks are supplied) and consists of just two files, the program itself and its help file. Most first-time users will want to purchase the Twin Pack, which contains two copies of the program and two manuals—Trax uses a proprietary transfer protocol and can only talk to another Trax-equipped PC, so you need copies for both users at each end of the phone connection.

The initial screen consists of four menu panes: Transfer Files, Answer Calls, Transaction Log, and Configuration. A master menu in the center selects the relevant pane and highlights it. All the menus feature drop shadows, a cursor bar, and highlighted first-letter shortcuts (which let you bypass the master menu). As in Borland's Turbo environments, all menus and dialog boxes remember your previous selection.

There are several global hot keys, such as the F2 key that always shells out to DOS; the F4 key that shows you the system time and date; and the question mark key (?) that initiates a text search inside menus, picklists, and even in the help screens, which is very handy.

The user interface has a Macintosh-like consistency that supports line editing, text searching, entry tagging, and point-and-shoot using the cursor bar in a picklist identically in every part of the program. The copious on-line help system is context sensitive and indexed with automatic cross-referencing.

Very little configuration is needed to run Trax—you just tell it your modem type, data transfer rate, and communications port. The defaults are Hayes Standard, 1200 bps, and COM1, so that many people will be able to run Trax immediately. Annoyingly, Trax does not support COM3 and COM4 ports.



THE FACTS

Trax 1.04
Twin Pack (two copies and two manuals), £195; Single Pack, £125

Requirements:
An IBM PC with 256K bytes of RAM, DOS 2.0, one floppy disk drive or a hard disk drive, and an asynchronous modem (preferably auto-dialing and Hayes-compatible).

East Coast Software
118 Rock Rd.
Booterstown
Co. Dublin
Ireland
353-1-831166
Inquiry 882.

Trax uses only a small subset of common Hayes commands to avoid compatibility problems with nonstandard modems. It supports data transfer rates of from 300 to 115,200 bps, although East Coast Software warns that some serial ports cannot run reliably at the latter speed even if the modem is willing. The modem types that Trax knows about are listed by name in a point-and-shoot picklist, with an editor so that you can enter the initialization and prefix strings for new non-Hayes modems, if required.

The telephone directory lets you store numbers and dial using short name codes. A similar directory holds a list of named groups; you can assign each number in the phone directory to one or more groups by simply tagging in a picklist. Groups could represent categories like Business and Personal, or regions like North, South, and West for a large corporation. You can instruct Trax to broadcast a particular file transfer command to all the numbers in a group by just selecting the group name.

continued

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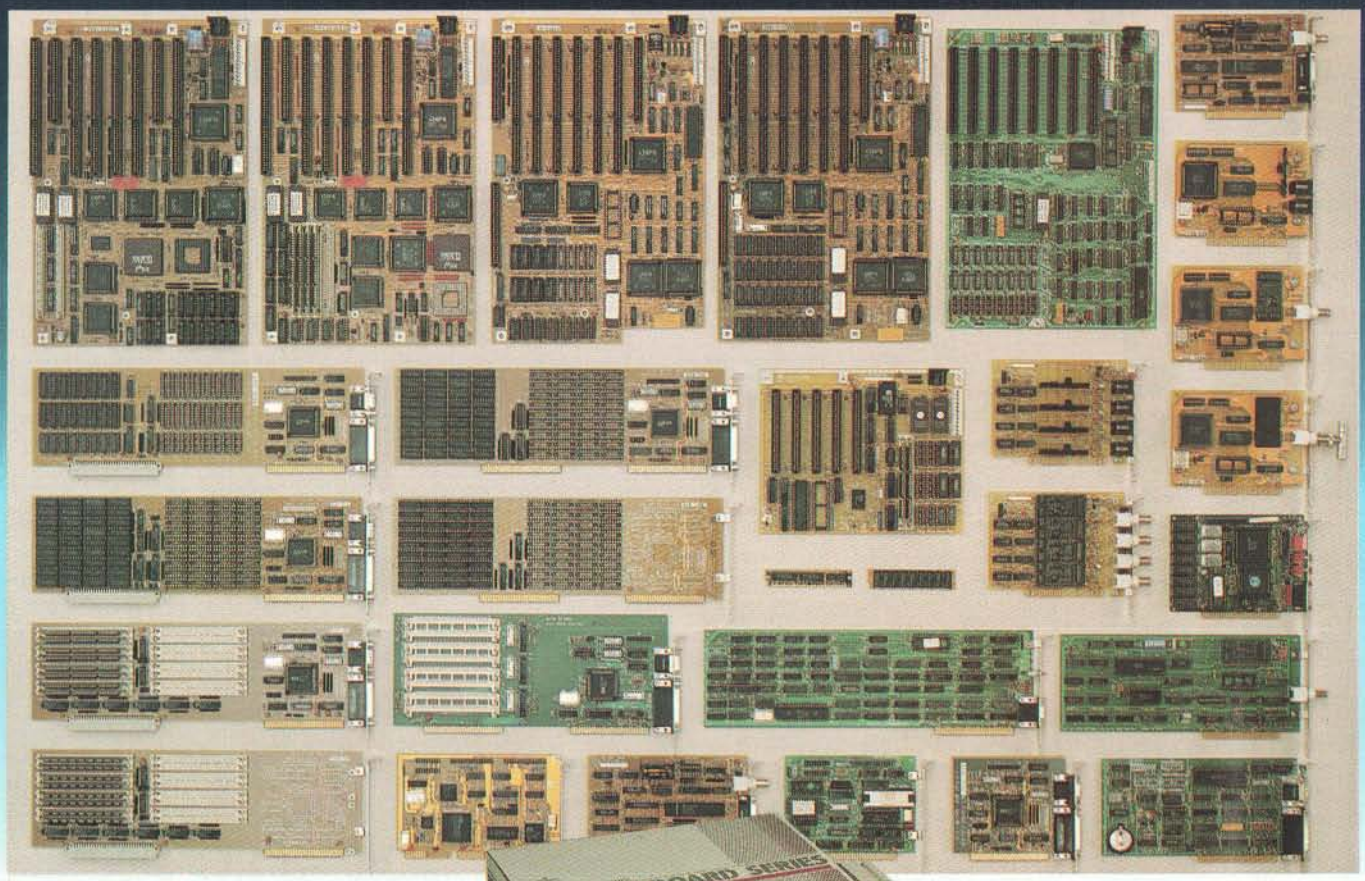

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There are three types of file transfer commands. Quick Transfer lets you select files and destination paths, using DOS wild-card file specifications or by picking and tagging, and then send them to or get them from the remote system. Copy options let you control copying of subdirectories, file overwriting, and hidden files. Interactive Transfer links you up to the remote system with your current directory displayed next to the remote system's current directory. Now you can copy, delete, rename, and so on, as if you were sitting at the remote system's keyboard. In addition, a Talk Window feature lets you converse with the operator of the remote system. Since this interactive facility is open to abuse, Trax provides a full security system with user names and passwords that lets you limit any user's access to certain directories or files.

Defined Transfer lets you create named transfer instructions that detail the files you want to transfer from one location to another. You create and edit these instructions in exactly the same way as phone and group entries. To execute a Defined Transfer, you simply select its name, but now you have the choice of performing the transfer immediately or at a specified time. Since Trax also has automatic call answering, you can have your colleagues set their remote systems to Wait For Call and then set the computer at the main office to automatically call and swap files with a whole group of remote sites, unattended and at off-peak times. You can achieve this with almost no typing by just picking names from lists and with no exposure to stop bits, parity, or log-in codes. It really does come very close to the convenience of a fax.

Trax also offers comprehensive logging of all calls. It lets you view the log in various ways (e.g., outgoing only), and you can ask it how a specific call was terminated. The package supports file encryption with user-supplied keys. You can also access the important features of Trax from a command line; for example, Trax Nightly Group North at 01:45, which performs the Defined Transfer nightly with all members of group North. This lets you build more sophisticated automated systems by using batch files.

I recommend Trax very highly, particularly to those in business who have fled back to fax after wrestling in vain with industry-standard personal computer communications programs. It's also a timely reminder that you don't need a graphics screen and 8 MB of memory to provide a nice user interface.

—Dick Pountain

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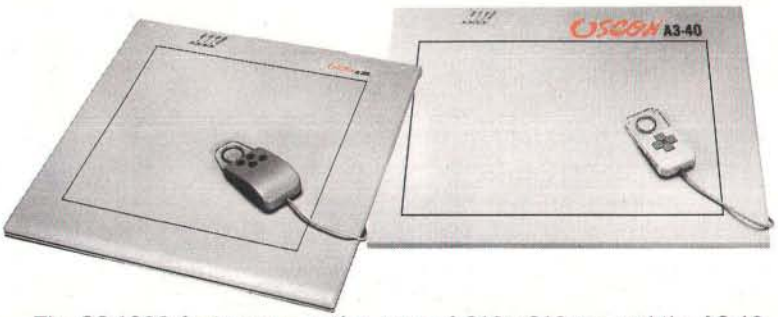

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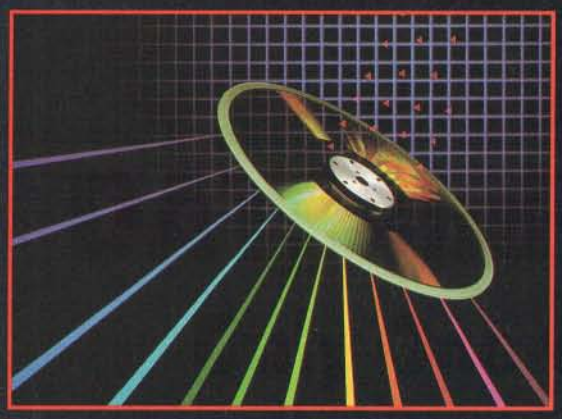

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MICROBYTES

INTERNATIONAL

Industry news and technological developments in the international microcomputer market

Written by Colin Barker

Apricot Sells Out to Mitsubishi

It was a sad day for the British computer industry. The last indigenous manufacturer of microcomputers, Apricot Computers (Birmingham, U.K.), announced recently that it is selling its hardware division to Mitsubishi Electric of Japan. The Japanese giant will take over all the manufacturing and distribution of Apricot's workstations and Micro Channel–based PCs and servers, as well as the Apricot name. Apricot Computers will group its remaining interests in computer services, software, and maintenance under the name ACT.

Mitsubishi is particularly keen to have the Apricot name and sees the purchase as a way to get into the highly competitive PC and workstation markets with an established business.

Apricot first became involved in microcomputers in 1981 when, as ACT, it acted as the distributor for Chuck Peddle's Victor/Sirius microcomputer. ACT achieved a success for that computer in Europe that Peddle could not find elsewhere. From that success ACT went on to develop its own non-IBM-standard range of computers: the Apricot line. After some success, the renamed Apricot group changed tack and started producing IBM-compatible systems. As recently as last summer, the company made headlines by announcing the world's first computer based on the Intel i486 CPU. But in recent years it has had a very shaky time, and a diversification into software and services proved to be necessary for it to survive.

Printing in the Palm of Your Hand

A Welsh company has launched what could be a major breakthrough in hand-held printers. The Printapen from Oyster Terminals (Newport, Gwent, U.K.) is an ink-jet printer that can be held in the hand like a pen. Sliding the face of the printer from left to right across most paper surfaces results in a well-spaced line (up to 64 characters) of draft-quality text.

The Printapen uses tried-and-tested technology in a novel way. The print mechanism is a single Hewlett-Packard ink-jet print head. This is linked to a small drive belt that moves over the surface like a caterpillar track. The speed of the belt dictates the speed at which the ink jet fires out characters.

The printer can accept standard ASCII data through an RS-232C port and has a 64-character buffer. It takes its power from the host system, but the company plans to produce a battery-powered version. There are also plans to increase the size of the buffer.

Product development manager Philip Satchell says that the printer will work with most paper surfaces and in various conditions; both the printer and its ink are resistant to water and temperature. It has two type styles (full and condensed) and can accept black, red, blue, and green ink. The ink-cartridge capacity is around 500,000 characters.

Barry Davis, Oyster's sales and marketing director, believes that the Printapen's market is big—the company hopes to be selling a million units a year by 1994—but he admits there are problems. "We've launched it now, before we are ready to ship in any kind of volume, to get the name and the product established before the opposition can move in," Davis says. Although the company has sought patents on the design, the use of established technology may make these difficult to defend against imitators. In the U.K., the Printapen will cost £249 (US$425).

continued

SEND US YOUR INTERNATIONAL MICROBYTES

If your company has a product or technology that affects the international microcomputer market, let us know. Contact BYTE's new International editor, Colin Barker, by telephone: 44-1-493-1451; fax: 44-1-493-9896; or mail: BYTE/McGraw-Hill, 34 Dover St., London W1X 4BR, UK. He can also be reached as "colin.b" on BIX.

NANOBYTES

As far as hardware goes, the **Hannover Fair** was a case of extremes. The most activity was at the top and bottom of the personal computer scale, with a host of new Intel i486-based machines, and laptops and notebook computers aplenty.

The Taiwanese Department of Trade had pulled the **Taiwanese industry** together to organize a mass invasion of the show. With 210 exhibitors, they were the third-largest national presence after West Germany and the U.S. Many of these companies are prodigious suppliers of systems to the West, but only through third parties. All of them seemed to be selling 486 systems (mainly towers) and portables—but the cases for these systems must come from the same supplier, because they soon became indistinguishable.

The most interesting of the new portables at Hannover was **Sharp's 6220** (a 4-pound notebook system), but Amstrad (Brentwood, Essex, U.K.) had a more conventional machine—at Amstrad's usual unconventional price. Amstrad, which has seen its share of its home U.K. market slashed by Toshiba, responded with systems that undercut similar Toshiba models by as much as £1800. The 16-MHz ALT-286 and ALT-386SX each weigh around 13 pounds and come with 1 MB of memory and 20- and 40-MB hard disk drives, respectively. Each has a floppy disk drive and a VGA backlit LCD and can run off batteries as well as main power. The ALT-286 is £1599 (US$2700); the ALT-386SX is £1999 ($3400). Amstrad has gone through a torrid time recently and is no longer the darling of the U.K. Stock Exchange. But all the signs are that there will be no letup in the launch of new products, or in chairman Alan Sugar's determination to compete with Far East suppliers on price.

continued

NANOBYTES

While the Japanese have become experts at portable computers, their home market for that breed of computer remains difficult. The problem is easy to understand. How do you produce a keyboard for a portable computer that incorporates the 2000 keys necessary to produce the minimum required kanji characters? The answer is, you don't; your market learns to use the English alphabet instead. But now Sony claims to have come up with something better: a hand-held computer that has a special pen and pad instead of a keyboard. The user writes the characters down on the pad, and, with the aid of fuzzy logic, the **Sony PalmTop** works out what is being written. Sony claims that the system recognizes 3500 kanji characters, as well as the English alphabet and graphics characters. It is being released in Japan at a price of around US$1000.

Microwriter Systems (Mitcham, Surrey, U.K.) has spent most of the last eight years trying to persuade an uncaring world that there is more to life than QWERTY keyboards. Back in 1982, the company came up with a notebook computer that used a special five-key keypad. You used the computer by grasping it in your palm and tapping out letters using two- and three-key combinations. The company claimed it was as fast as a standard keyboard, if not faster. It also had other advantages: It was much smaller than a standard keyboard and was especially useful for one-handed people. It never caught on, but it's still around in the shape of the Agenda computer that incorporates a standard keyboard and a Microwriter pad. Now Microwriter has come up with **Agenda BASIC Code**, which is a BASIC compiler that incorporates a cross compiler for use with PCs. The company hopes that it will be much easier for developers to come up with applications for the Agenda system since they can develop them on a standard PC. Microwriter says that although it is not BASIC per se, Agenda BASIC Code follows that language pretty closely, and applications written in BASIC can be ported to the Agenda with "minimum adaptation."

French Company Introduces 486 EISA System

Germany might be reuniting, but the high-end personal computer market in Europe is dividing. Europe was once thought of as a strong bastion of support for IBM's Micro Channel architecture, but the recent CeBit Fair in Hannover, West Germany, revealed an increasing interest in rival Extended Industry Standard Architecture (EISA) systems.

Indeed, the dozens of i486-based systems scattered among the 4000-plus exhibitors at the huge fair suggested that Europe and the rest of the world will not lag behind the U.S. when it comes to implementing the latest hardware.

Perhaps the most impressive new 486 machine was from a company called Goupil (Creteil, France). The company unveiled its 486 (and four other new systems) in Paris the day before CeBit began.

Goupil claims to be the second-largest French computer company, after Groupe Bull. Little-known outside of France, Goupil has large subsidiaries in the U.K., Spain, and Germany, and smaller companies in various other countries, including Poland and the U.S.S.R.

Goupil will sell its i486-based G60 as a departmental supermicrocomputer. The computer runs the i486 processor at 25 MHz on a standard EISA board. A Weitek WTL4167 math coprocessor is optional. The standard 4 MB of RAM is expandable to 64 MB. A Super VGA graphics controller and a "multiformat" disk drive controller are standard. Various disk drive options are available, with a maximum of two 1.2-gigabyte drives using a SCSI controller. There are six EISA and two Industry Standard Architecture expansion slots. Goupil will supply MS-DOS 4.0, OS/2 2.1, or Unix System V 3.2 with the system.

The company makes light of the reported problems with the i486 chip and says that the first G60 systems will be shipping by the time you read this at a price of around 120,000 French francs (approximately US$21,000), depending on configuration.

As if to hedge its bet on the EISA/Micro Channel debate, Goupil recently bought Normerel, another French computer manufacturer. Normerel has been manufacturing Micro Channel–compatible systems for sale to OEMs.

Goupil also launched some new versions of other systems at the lower end of the power spectrum. One of these, the Goupil Golf, is a neat portable with a separate keyboard and a VGA-compatible backlit LCD. Already available in 286 and 386SX (16-MHz) versions, it has won design awards in Germany, France, and Spain. The new version has a 20-MHz 386SX, one of the first in a portable.

Husky Computers' Hand-Held DOS System

Husky Computers (Coventry, U.K.), a manufacturer of hand-held terminals, has upgraded its PC-compatible Hunter computer with a faster processor and enlarged RAM. Like all of Husky's computers, the Hunter 16 is intended for applications such as data collection.

The new Hunter 16 is one of the smallest PC compatibles on the market, measuring 8½ by 6$^{1}/_{10}$ by 1$^{3}/_{10}$ inches and weighing in at 2$^{7}/_{10}$ pounds. It uses the NEC V25 (8086-compatible) processor and can carry up to 2.2 MB of RAM. There are no disk drives.

MS-DOS 3.3, GWBASIC, and various software utilities are held in ROM (up to 1 MB), and for those who want more certain storage than RAM, 128K bytes of flash EPROM is available as an option.

Built to rugged standards, the Hunter 16 is designed to let you rattle it around, shake it up, and spill things on it without worrying too much. It has a tough aluminum alloy case and a sealed keyboard that includes a separate numeric keypad.

The display is an 8-inch CGA screen that can be configured to 8 rows of 40 columns or 10 rows of 60 columns as windows in a virtual screen of 25 rows by 80 columns.

The Hunter 16 runs on standard AA batteries, which provide about 30 hours of power. Nickel-cadmium rechargeables are optional. Single-unit prices start at £1995 (US$3400).

Husky has been making hand-held computers for 10 years now; in that time, the company has built up a wide range of peripheral products, including disk drives and printers. A battery-powered 3½-inch floppy disk drive and 24- or 42-column printers are available for the Hunter 16.

SIEMENS

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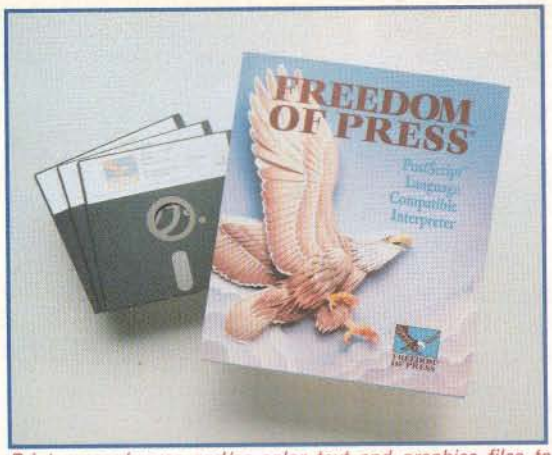

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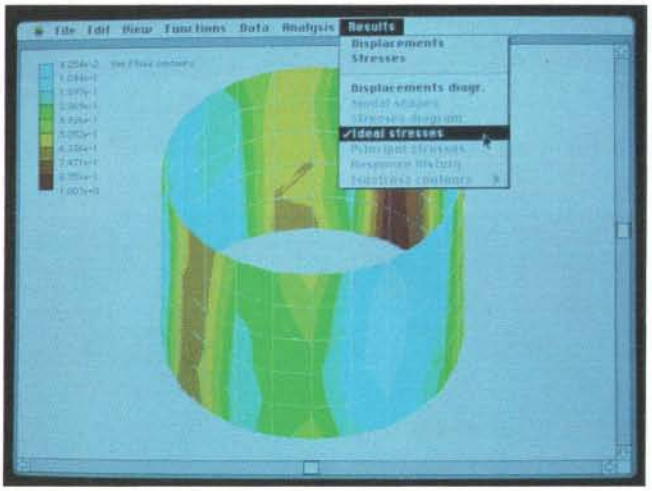
New Features for MacSap

Softing has recently added a true Macintosh interface, four-node finite elements, surface modeling, triangularization, Von Mises Contours, a CAD interface, postprocessors, and expanded operative limits to MacSap IV, the latest version of its linear elastic analysis program for generalized three-dimensional structures (see What's New International, September 1988, page 88IS-8).

New finite elements in MacSap IV's library are designed for mechanical engineering. New surface-modeling methods help you model complex surfaces, and the triangularization function lets you automatically divide bounded surfaces into triangular elements. The addition of the Von Mises Contours gives you spectacular contour lines with color fields.

A utility program called SapMover lets you link MacSap to CAD programs to achieve an integrated working environment. The two new postprocessors for MacSap IV are MacBeam 4.0 for reinforced concrete design and CADSap 1.2 for formwork design.

MacBeam 4.0 designs beams subjected to combined bending and axial loads and columns subjected to biaxial bending. It solves the scientific problem of determining the required steel and the technical problem of bar layout; it also lets you intervene on the drawing to make any required changes. You can save drawings in IGES format and export them to CAD programs. You can also reproduce drawings on printers and plotters; MacBeam supports Hewlett-Packard, Houston, and Benson plotters.



The addition of Von Mises contours to MacSap IV gives you spectacular contour lines with color fields.

CADSap 1.2 permits automatic drafting of formworks for reinforced concrete structures that you have analyzed with MacSap. It offers maximum automation for technical bureau production by directly producing formwork drawings from the same data utilized for structural analysis. To obtain the drawing of the formwork plans, CADSap transforms MacSap wireframe models into solid models using the cross-section dimensions of columns and beams. CADSap then performs a section at the elevation you require and eliminates the superposition lines.

MacSap IV requires a Mac II with 2 MB of RAM and a color monitor.
Price: US$4300 for MacSap IV; $1500 for MacBeam 4.0; $1200 for CADSap 1.2.
Contact: Softing srl, Via Reggio Calabria 6, 00161 Rome, Italy, 39-6-42-61-01.
Inquiry 904.

Color Dot-Matrix Printing

The NPC 136-24 color dot-matrix printer leads AEG Olympia's range of 24-pin machines, which also includes the NP 80-24 and the NP 136-24.

All three printers include five built-in letter-quality fonts in addition to draft mode—Courier, Prestige, Gothic, OCR-B, and Optimo—in 12 pitch settings from 5 cpi to 20 cpi and proportional. Emulations include Epson LQ and IBM Proprinter, and the printers come with both Centronics parallel and RS-232C serial interfaces.

The printers also feature Zero-Inch Tear-Off paper handling and paper parking.

The NPC 136-24 can produce letter-quality documents and high-quality graphics in seven colors. The printer's 24-pin printhead can print in a wide range of fonts and pitch sizes that you select via the operator panel or software. You can print in draft, normal, and italic styles and in 10, 12, Condensed, Expanded, or Proportional spacing. The NPC 136-24 also offers the option of rear or base paper feed for continuous stationery. An optional single- or twin-bin sheet feeder is available for all models.

You can upgrade the 16K-byte print buffer to 32K bytes. A 16-character LCD panel shows current font selection and printer status, as well as settings for the print parameters. Print speeds are 240 cps in draft mode and 80 cps in letter-quality mode for the 136 models, and 200 cps in draft mode and 67 cps in letter-quality mode for the 80-column model.
Price: £698 for the NPC 136-24; £548 for the NP 80-24; £598 for the NP 136-24.
Contact: Olympia Business Machines Company Ltd., Olympia House, 199/205 Old Marylebone Rd., London NW1 5QS, UK, 44-1-262-6788.
Inquiry 903.

Epson's Color Laptop

The first model in Seiko-Epson's new color laptop range is the 386-based PC-386LS with a super-twisted nematic (STN) color LCD panel. The second model will have a metal insulator metal (MIM) color LCD panel.
Price: 600,000 to 700,000 yen for the STN color LCD panel model; 800,000 yen for the MIM color LCD panel model.
Contact: Seiko-Epson Corp., 3-3-5 Ohwa, Suwa, Nagano-ken 392, Japan, 81-0266-52-3131.
Inquiry 1135.

continued

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More TRAMs from Mark Ware

Mark Ware Associates has added three more transputer modules to its family of TRAMs and TRAM motherboards. The TM8022SB is a low-profile Size 2 TRAM with 2 MB of surface-mounted zero-wait-state DRAM, and the TM8082SB is the same TRAM but with 8 MB of DRAM. The company can supply both TRAMs with one or more upper decks carrying additional memory or other options. A TRAM with three decks, called the TM8242SB, comes with 24 MB of DRAM in a package just over 25 mm thick.

The TRAMs come with an Inmos T800 floating-point transputer or a T425 transputer; a clock speed of 20 or 25 MHz; and 2, 4, 8, 16, or 24 MB of DRAM. The 25-MHz version of both transputers has a throughput of 12.5 MIPS; the T800-25 can process about 2 MFLOPS. Four pairs of bidirectional serial links provide a maximum communications bandwidth of more than 9 MBps.

Price: £1195 and up.

Contact: Mark Ware Associates, 96 Queens Rd., Bristol BS8 1NS, UK, 44-272-238623.

Inquiry 958.

Flatbed A1- and A2-Size Plotters

The new models in Roland Digital Group's DPX range of flatbed plotters, called the DPX-3500 and the DPX-2500, offer higher resolutions and the ability to produce multiple copies of the same plot.

The DPX-3500 and DPX-2500 have a maximum plotting speed of 62 cm per second in all directions and can handle up to eight pens; automatic pen-sensing sets the correct writing speed and pen pressure for each pen. The plotters also let you plot with pencils—they record the plotting distance of each pencil and select a new one before running out of lead.

The 24-character by 2-line LCD panel provides simplified operation and setup and displays configuration and pen information. A replot facility lets you plot multiple copies of drawings stored in the buffer, and a power-surge-protection device protects this data and any other stored parameters in the event of a power failure.

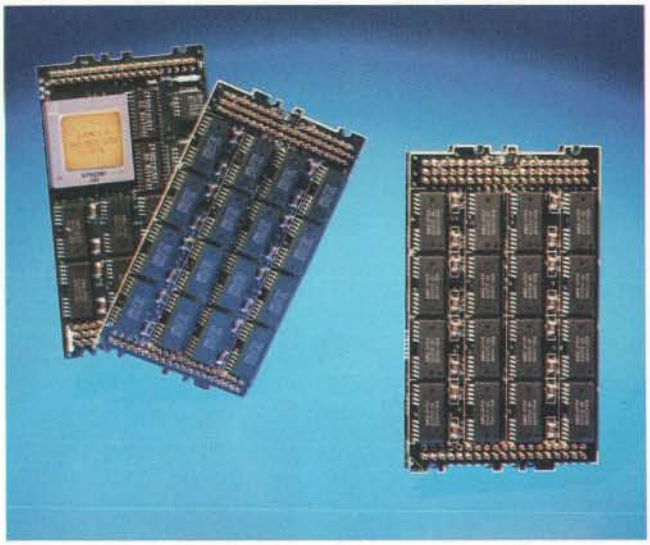
If you have limited workspace, the DPX plotters' tilt mechanism lets you operate them at up to a 60-degree angle. The built-in slant sensor automatically compensates with an increase or decrease in pen pressure. Each plotter also has a pen and accessory storage compartment, as well as paper-storage trays built into the stand.

The DPX-3500 A1-size plotter has a maximum plotting area of 924.4 by 619.6 mm, measures 1251 by 888 by 177 mm, and weighs 30 kg. The DPX-2500 A2-size plotter has a maximum plotting area of 619.6 by 467.2 mm, measures 945 by 735 by 177 mm, and weighs 24 kg. Both models come with a 1-MB data buffer, an electrostatic paper-holding system, and Centronics parallel and RS-232C serial interfaces that automatically configure themselves. Other features include a mechanical resolution of 0.00006 inch and a facility that lets you increase the distance accuracy for applications that require measurements taken directly from the plot.

Price: £4950 for the DPX-3500; £3450 for the DPX-2500.

Contact: Roland Digital Group, Amalgamated Dr., West Cross Centre, Brentford, Middlesex TW8 9EZ, UK, 44-1-847-5665.

Inquiry 901.



The TM8022SB, TM8082SB, and TM8242SB TRAMs come with an Inmos T800 floating-point transputer or a T425 transputer, a clock speed of 20 or 25 MHz, and 2, 4, 8, 16, or 24 MB of DRAM.

New Version of Norton Commander

Norton Commander 3.0 simplifies and enhances DOS for business users. It helps you manage your data files, view them, and transfer them electronically anywhere in the world. For laptop users, Norton Commander 3.0 includes display options adapted for LCDs.

Expanded file viewers let you quickly view files in their proper formats without loading the application with which you created them. In addition, the file viewers support most of the leading business application software, including dBASE, Lotus 1-2-3, WordPerfect, and PC Paintbrush.

The Quick Views feature simultaneously displays the contents of a data file and the list of files in a directory, so you can quickly browse through data files. Once you locate a specified document, you can load the data file and application automatically with a single keystroke using Commander 3.0's point-and-shoot operation.

Other new features include Commander Mail, an automated E-mail feature that lets you send documents with just a few keystrokes, and Commander Link, which lets you transfer files between any two IBM PCs via a serial-port connector cable.

Norton Commander 3.0 runs on an IBM PC with DOS 2.0.

Price: $99; £19 for the optional cable to use Commander Link.

Contact: Peter Norton Computing UK, Wimbledon Business Village Center, Thornton House, Thornton Rd., London SW19 4NG, UK, 44-1-944-1765.

Inquiry 930.

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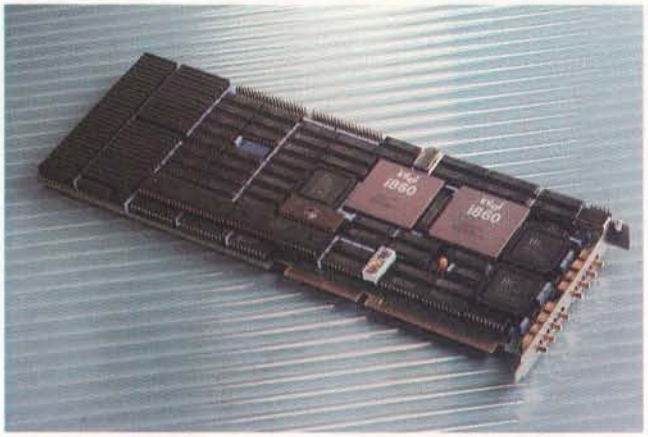
Circle 416 on Reader Service Card (DEALERS: 417)

Turn Your IBM AT into a 3-D Graphics Supercomputer

You can turn your IBM AT into a three-dimensional graphics supercomputer with the Reality PC add-in board from Real World Graphics. The board is designed for real-time animation and simulation applications.

The board has two Intel i860 processors running in parallel, 3.5 MB of video RAM, 4 or 16 MB of DRAM, and a palette of 16.7 million colors. The resolution is software selectable from NTSC to 1024 by 768 pixels noninterlaced or anything in between. Typical 3-D performance figures are 100,000 Gouraud polygons per second and 500,000 10-pixel vectors per second.

Reality PC supports the Reality Graphics Library, a set of real-time 3-D functions for animation and simulation.
Price: £12,000.
Contact: Real World Graphics Ltd., 5 Bluecoats Ave., Bluecoats, Hertford, Hertfordshire SG14 1PB, UK, 44-992-554442.
Inquiry 943.



Reality PC is designed for real-time animation and simulation applications.

Microsoft Word for Windows

Microsoft Word for Windows, a graphical word processor for 286- and 386-based IBM PCs, has the standard features of a character-based word processor and introduces several new capabilities in four catagories: graphical user interface, compound document creation, customization, and transition from other word processors.

During the editing process, the on-screen WYSIWYG format displays exactly how a printed document will look. You can reposition margins, outline headings, and graphics by dragging with the mouse, and you can change to non-WYSIWYG draft view for maximum text-entry and editing speed. Intuitive new formatting aids facilitate character and paragraph formatting. Word for Windows graphically presents all basic formatting commands (for typeface, spacing, margins, and attributes such as bold and italics) and lets you easily control and revise them.

You can integrate graphics, tables, spreadsheet data, charts, and scanned images into a Word for Windows document. The Tables feature gives you spreadsheet-like manipulation of text, numbers, and graphics. You can define variable-width columns, merge or delete cells, automatically wrap text within cells, enter cell formulas, and draw borders. Word for Windows also lets you import a variety of graphics and quickly size or crop them. In addition, you can fix a chart, image, paragraph, or tablet on the page, with text automatically wrapped around its border.

Dynamic Data Exchange lets you also keep hot links to the source data from other Windows applications for automatic updating. For example, when you change data on a Microsoft Excel spreadsheet, a Word for Windows file with a DDE link to the spreadsheet can be updated automatically.

Customization features help you automate routine and complex tasks with document templates. To quickly perform frequent tasks, you can record macros and assign them to the keyboard or menu for easy access. Glossaries store frequently used information or images, such as boilerplate text or a company logo. Style sheets let you save character and paragraph formats for inserting anywhere in a document.

You can automatically read and write documents from Microsoft Word for the IBM PC, Microsoft Windows Write (read only), WordPerfect 5.0, MultiMate, DisplayWrite, WordStar, and Microsoft Works without using separate conversion utilities, while preserving all text formatting. Using the Rich Text Format feature, you can share files directly with Microsoft Word for the Mac. In addition, Word for Windows lets you import graphics and images from TIFF, PIC, CGM, AutoCAD, Hewlett-Packard Graphics Language, and other graphics file formats.

Word for Windows requires a 286- or 386-based computer, 640K bytes of RAM, a hard disk drive, and a graphics card.
Price: £445; £120 as an upgrade for current users of any version of Microsoft Word.
Contact: Microsoft Ltd., Excel House, 49 De Montfort Rd., Reading, Berkshire RG1 8LP, UK, 44-734-500741.
Inquiry 931.

DTP for the Atari ST

Signa Publishing claims that its Calamus package is the desktop publishing solution for the Atari ST. The program contains word processing, page and layout design functions, typesetting capabilities, and design tools, and it lets you import graphics and text.

The GEM interface provides pull-down menus, icons, dialog boxes, ranging, and scroll bars. It also offers use of a mouse, optional keyboard glossaries, macro commands, on-screen help lines, a choice of presentation types (including double page, page overview, and full screen), and a choice of presentation sizes (including full page, normal, and magnified from 0 to 999 percent).

Text-editing features include direct text input into layout, an additional fast text editor in its own window, block-editing line rulers, margins and tab controls, search and replace, indexing and table of contents, footnotes, algorithmic hyphenation, a hyphenation dictionary, cross-reference management, and five text clipboards.

You can adjust the layout format in inches, millimeters, or pica points; adjust the margin and column settings; and lay out a horizontal or vertical page format. The maximum page size is 700 by 700 mm. Other layout features

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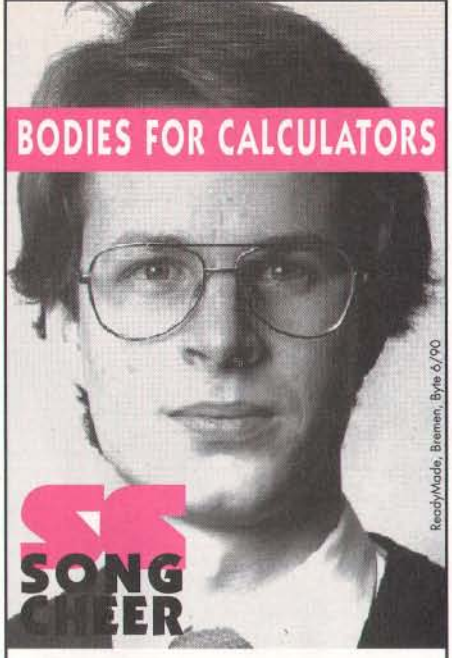

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Calamus requires an Atari ST with 1 MB of RAM, a high-resolution monochrome monitor, and a double-sided floppy disk drive.

Outline Art is a vector-oriented, graphics-based program for Calamus that provides functions and effects that include a vector/Bézier curve graphics editor; freely definable ray tracing; almost unlimited possibilities for text manipulation, characters, and font attributes; and automatic and manual kerning.

The package also lets you create smooth raster gradients in any direction, flow text around any vectored path, project rasters and text to the inside of any vectored shape, and convert text to a vectored object.

You can freely combine and apply the functions of Outline Art to Calamus fonts. In addition, you can load and save in Calamus Vector Graphic (CVG) format, providing direct input of Outline Art files, which you can then print on any output device supported by Calamus.

An integrated calculator has predefined and user-programmable function buttons, with formulas such as move, rotate, mirror, enlarge, reduce, and create spherical objects already in place. Intelligent clipboard and copy functions let you define and execute complex sequences.

Outline Arts requires a 1-MB Atari ST with an SM124 monochrome monitor or an approved A3 monitor.
Price: £399 for Calamus; £150 for Outline Art.
Contact: Signa Publishing Systems Ltd., Alexander House, Station Rd., Aldershot, Hampshire GU11 1BQ, UK, 44-252-341600.
Inquiry 933.

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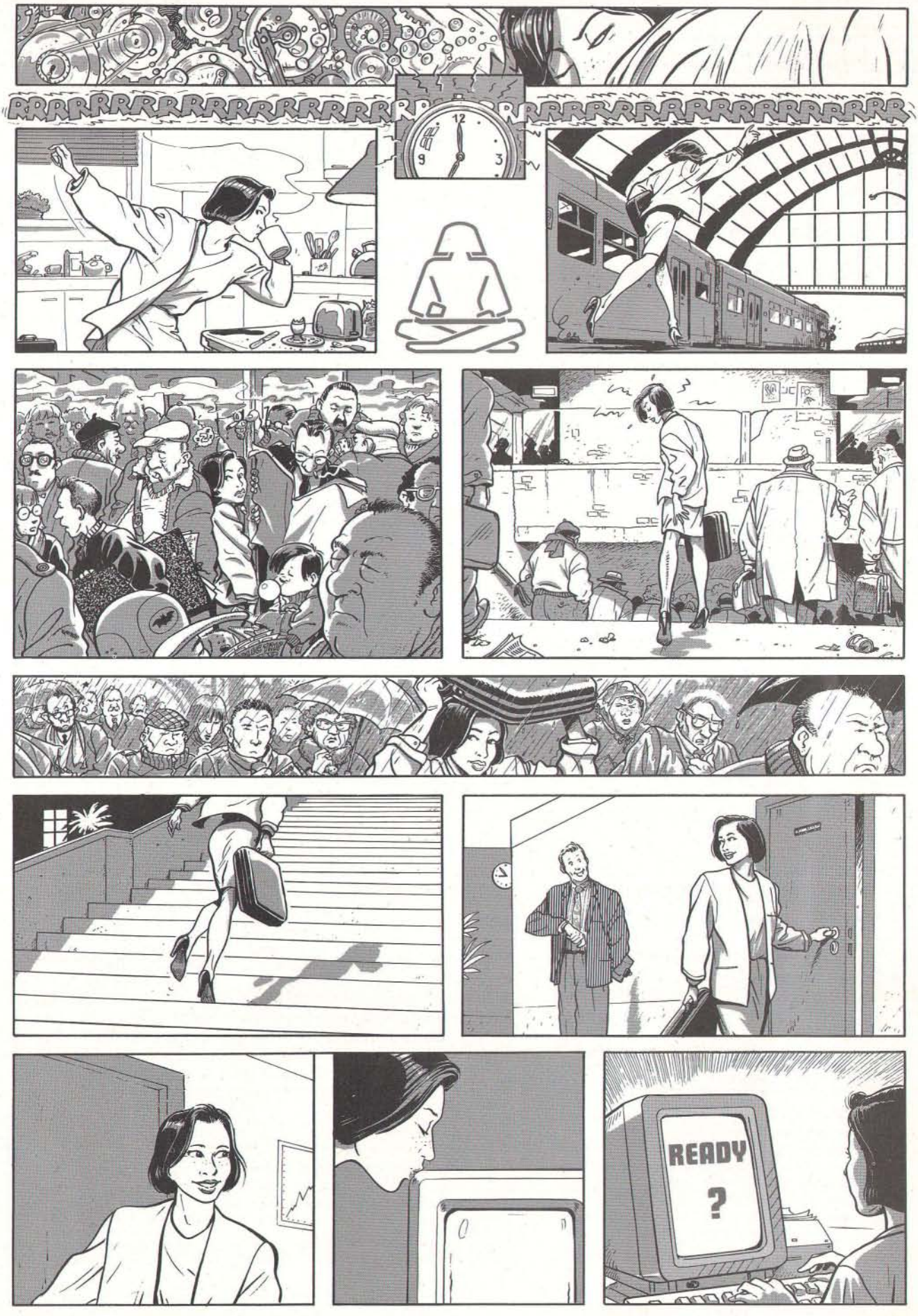
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The cisco multiprotocol routers let you use one common set of communications links for all data traffic—users can select the protocols they currently want to use and later run new ones without adding to or changing the hardware. Other protocols already supported by the cisco routers include TCP/IP, DECnet, X.25, AppleTalk, and various XNS implementations.

The introduction of Novell IPX support makes cisco routers ideal for a company's personal computer internetworking needs; cisco routers can also internetwork 3Com, Ungermann Bass, and IBM/Microsoft PC-LAN Manager. In addition, cisco's Source Route Bridging allows a cisco-based network to handle System Network Architecture protocols between PCs and IBM hosts.

The addition of ISO CLNS plus cisco's support for X.25 and ability to bridge ICL OSLAN all within one common backbone network means that you can put government OSI profile (GOSIP) migration plans into effect now. As with all cisco protocols, you can add new protocols without additional hardware.

You can connect multisite Ethernet, Token Ring, and Fiber Distributed Data Interface (FDDI) LANs and create a wide-area backbone from diverse media such as Kilostream, Megastream, X.25, satellite, microwave, and fiber-optic links.

The routers operate at Level 3 of the OSI model (the network layer), while offering a level of performance (12,000 routed packets per second) previously found only in Level 2 bridging products. Level 3 routers support redundant routing and automatic rerouting upon link failure, access controls to govern which users can access which parts of a network, and network management facilities for troubleshooting and gathering usage statistics. The cisco routers also feature the proprietary interior gateway routing protocol, which performs dynamic load balancing on all network links to ensure fastest response times for all traffic.

Price: £8600 with two Ethernet interfaces and two 64K-byte serial interfaces; £15,040 with two Ethernet interfaces, two high-speed 4-Mbps serial interfaces, and one Token Ring interface; £41,000 with one FDDI, four Ethernet interfaces, four high-speed 4-Mbps serial interfaces, and two Token Ring interfaces. All prices include software for 14 routed protocols at Layer 3 of the OSI model.

Contact: Chernikeeff Telecommunications Ltd., Church Wharf, Pumping Station Rd., London W4 2SN, UK, 44-1-995-7855.

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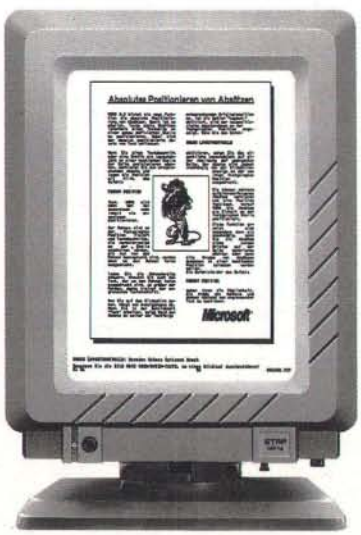

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With the Retix 4880 remote Ethernet bridge, you can transfer information at very high speeds between LANs located at remote sites. The Model 4880 can support two links simultaneously, each operating at up to 2 Mbps. Using multiprocessor hardware, the bridge can filter data at the full Ethernet rate of 14,880 frames per second with a throughput of more than 8000 frames per second across the wide-area network (WAN).

A menu-driven management system lets you monitor the performance of, and manually configure, any bridge in the network. The 4880 provides data prioritization and multilevel frame filtering, thereby minimizing extraneous WAN traffic. In addition, the bridge offers multicast and broadcast frame-filtering facilities.

The unit is self-configuring, with error detection and correction hardware and software. It automatically selects the correct LAN type, WAN speed, and active or stand-by operation. The locations and addresses of network-oriented devices are also automatically learned, based on traffic flow. The 4880 actively monitors network traffic and automatically keeps bandwidth occupation to a minimum. It also supports X.21, RS-499, and V.35 interfaces operating at user-defined rates.

The 4880 bridge comes with one WAN interface module, which you can select according to the type of WAN in use. Retix Systems can also supply a second WAN module as a factory-installed option.

The Retix Systems' 4880 LAN bridge can drive two 2-Mbps Megastream and T1 wide-area network links simultaneously.

The following modules are available: X.21, V.35, RS-449, G703, and T1 interfaces.
Price: £7000 per bridge half.
Contact: Retix Systems Ltd., Alan Turing Rd., The Surrey Research Park, Guildford, Surrey GU2 5YF, UK, 44-483-300600.
Inquiry 910.

A CASE Tool for Business

Westmount Technology's Information Systems Engineering Environment (ISEE) 1.5 is a CASE environment designed for project teams that develop business information systems applications based on a relational DBMS. The generic version supports analysis, design, implementation, project management, and documentation and lets you generate ANSI Structured Query Language code, which you can run on any DBMS that supports this standard. A specific Ingres version, ISEE/Ingres, is also available that is fully integrated with that database.

The user interface of ISEE 1.5 is implemented using the X Window System with full use of multiple windows, icons, and a mouse. The user interface shows a three-layer architecture, with the desk at the top level. The desk provides general access to the system for creating projects, administration, configuration, utilities, and starting workbenches. A workbench, which is in the second layer, reflects the state of the development—you can select from the ISEE/Analyst, ISEE/Architect, ISEE/Designer, ISEE/Programmer, ISEE/Documenter, and ISEE/Manager workbenches. Each workbench consists of a browser containing a list of all project data related to the state of development. By selecting an item, you can start the corresponding editor, the third and last layer of the user interface.

The ISEE/Analyst workbench supports structured techniques meant for information and systems analysis. This stage of development is supported by the following tools: Data Flow Editor, Entity Relationship Editor, and Data Structure Editor.

The ISEE/Architect workbench tools support the global design phase. They allow activities in the data flow diagrams, entity relationship diagrams, data structure diagrams, and state transition diagrams.

With the ISEE/Designer workbench, you can define the structure of the application in more detail, describing modules and their hierarchical relations. From the diagrams, you generate code for both the data view and the procedure view. The Designer workbench consists of the Structure Chart Editor, Data Structure Editor, and Entity Relationship Editor.

The ISEE/Programmer workbench is a programming environment for the implementation and testing of the end product. It offers 4GL functionality and lets you modify and manipulate the whole application and the database.

ISEE 1.5 contains an integrated Documenter workbench for building technical and user-oriented documentation according to a predefined standard. With the Documenter workbench, you can compose a document from all items like diagrams, text, tables, and relations defined in the Analyst, Architect, Designer, or Programmer workbenches. You can then print this composition or export it to a WYSIWYG documenting system.

You can keep track of a project's progress as well as control it using the Manager workbench. It offers facilities for work breakdown, estimation, scheduling, monitoring, and reporting. All project information is based on data from the project's actual analysis, design, and implementation.

ISEE 1.5 is available on Sun-3, Sun-4, and Sun386i; Apollo 3000/4000 and 3500/4500; DEC VAX/VMS, VAX/Ultrix, and DECstations; Sequent Symmetry; Siemens MX500; and 386-based IBM AT machines.
Price: US$5000 to $10,000 per workbench.
Contact: Westmount Technology, P.O. Box 5063, 2600 PA Delft, The Netherlands, 31-15-610815.
Inquiry 915.

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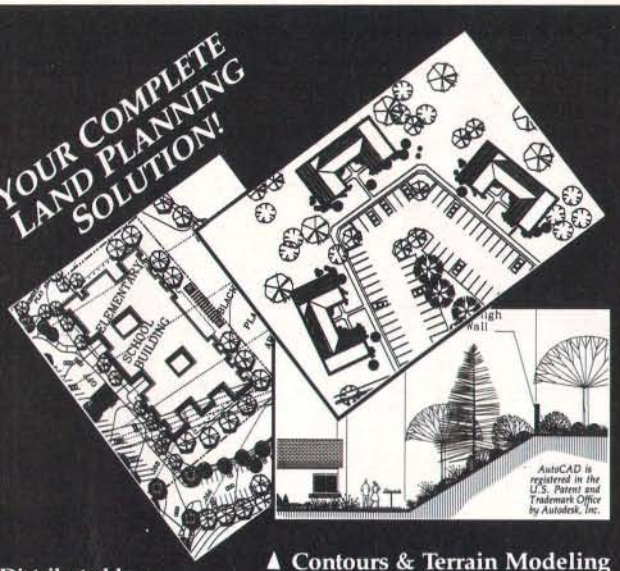

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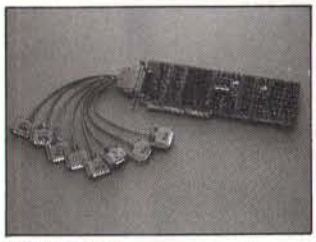

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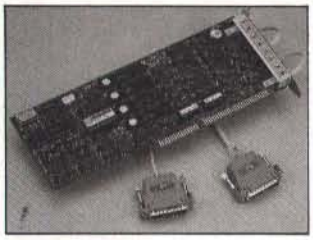

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Design Time-Series Models

If you would like to evaluate or design advanced time-series models, gain a clear understanding of current methods used in data management and analysis, or find a convenient econometric time-series program, then you should look into Microfit from Oxford Electronic Publishing. The software is an interactive, menu-driven program designed for the econometric analysis of time-series data.

In business, you can use the program for estimating, testing, and forecasting. In research, you can use Microfit to estimate equations by alternative methods, modify and compare them in rapid succession, and obtain instant feedback and guidance using its variety of diagnostic tests and statistics. In education, students can explore well-known and more advanced econometric techniques interactively and at their own speed.

Microfit accepts ASCII and binary files and lets you extend, revise, and merge data files. You use simple commands to perform data processing, and you can store these commands for later use to simplify routine and repetitive tasks. If your computer has sufficient memory, you can also access other software in the operating system while still in the program.

The package lets you input data as undated series, or as monthly, quarterly, half-yearly, or yearly frequencies; extend files by adding further observations and variables; compute new series as algebraic transforms of existing data; and generate time trends, seasonal dummies, and random numbers from uniform and normal distributions.

You can generate repeated transformations of different or revised data sets by running batch jobs consisting of simple commands and formulas. Microfit helps you generate high-quality graphs and print out hard copies on any Epson-compatible dot-matrix printer. You can automatically produce graphs of actual and fitted values, residuals, forecasts, and concentrated log-likelihood functions.

Microfit's computations in general statistics include means, standard deviations, the coefficient of variation, the minimum and maximum of a series, as well as its autocorrelation function, Box-Pierce and Ljung-Box statistics, and the matrix of correlation coefficients.

The software estimates regression equations (up to 30 regressors) under a variety of stochastic specifications. Possible estimation techniques include ordinary, recursive, and two-stage least squares; generalized instrumental variables; Cochrane-Orcutt Iterative Technique; and exact minimum likelihood and instrumental variable estimation of models with serially correlated errors.

The results are tabulated compactly and provide parameter estimates and other statistics of interest, including T-statistics, standard errors, Durbin-Watson statistics, Durbin's h-statistic, and R-Bar-squared.

Microfit requires an IBM PC with 512K bytes of RAM (640K bytes is recommended if you want to incorporate larger data sets), DOS 2.0, two floppy disk drives or a hard disk drive, and a graphics adapter. The company recommends an 8087 math coprocessor to speed up computations.

Price: £195.

Contact: Oxford Electronic Publishing, Walton St., Oxford OX2 6DP, UK, 44-865-56767.

Inquiry 912.

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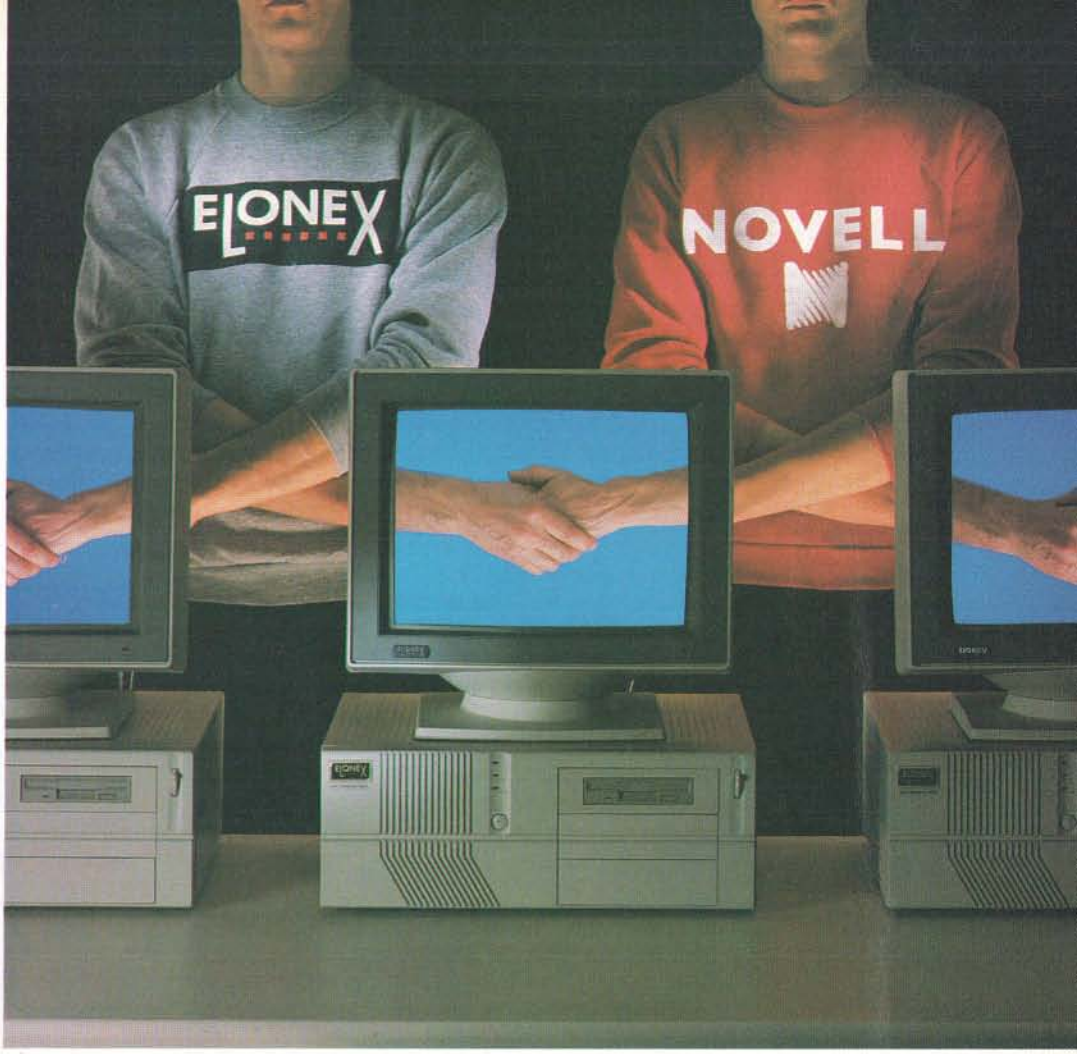

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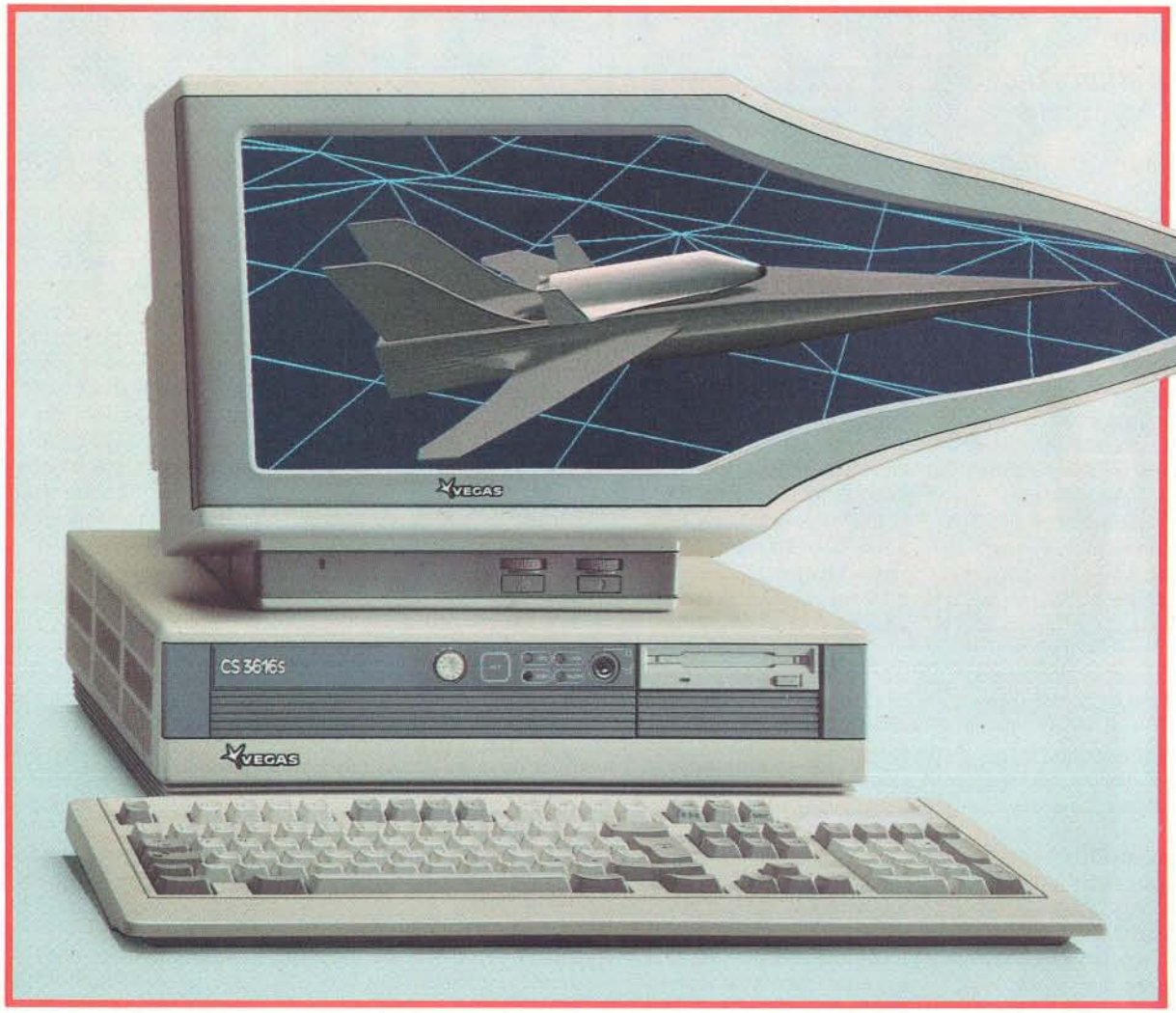
Being compatible is good enough. Or is a flexible computer better?



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Reflex Technology's PL1000 logic analyzers can accommodate up to 192 channels and acquisition speeds of up to 1 gigahertz.

High-Performance Logic Analyzers

The PL1000 family of high-performance logic analyzers from Reflex Technology can accommodate up to 192 channels and acquisition speeds of up to 1 gigahertz. You connect the units to an IBM AT via a half-size parallel interface card.

The devices have a modular architecture that lets you configure them to your own requirements. The recording modules provide sophisticated features such as glitch capture down to 3 ns, time stamping, 15-level triggering, and true time correlation between modules at full speed.

You capture signals via active logic probes of 2 MOhm/5 pF impedance. Disassemblers are available for almost all microprocessors, including 32-bit devices, and the units can accommodate multiprocessor applications. In addition, the PL1000 analyzers support signal processors like the TMS320.

The PL1000 can accept up to three logic-analyzer modules, or you can install two logic-analyzer modules and one pattern-generator module, which lets you produce output patterns on up to 64 channels at 50 MHz.

The operating software runs under Microsoft Windows and lets you display multiple windows in one screen; you can show data lists, timing diagrams, and disassembler lists simultaneously. The time-correlation feature gives analysis power for complex state, timing, or combinational debugging problems. You control all functions using a mouse or the keyboard. Pull-down menus or simple keystrokes adapt the level of operation to your specific experience.

Two versions of the unit are available: the PL1000 tower unit and the PL1000 Plus. The PL1000 tower unit requires 640K bytes of RAM (2 MB recommended), DOS 3.0, a 20-MB hard disk drive, Microsoft Windows 2.10, and a graphics adapter, a printer, and a mouse that support Microsoft Windows. The PL1000 Plus comes with an integrated 12-MHz 286 AT-compatible computer, 1 MB of RAM, a 3½-inch floppy disk drive, a 20-MB hard disk drive, an AT keyboard, two RS-232C serial interfaces, one parallel interface, a mouse, and a 9-inch monochrome display. A video output for an external monitor is provided, as well as an interface for an external 5¼-inch floppy disk drive and three 16-bit AT slots. The operating software runs under DOS 3.3 and Microsoft Windows 2.10.

Price: £16,000 for the PL1000 tower system with 64 channels/100 MHz; £22,000 with 48 channels/100 MHz and 24 channels/500 MHz; £19,500 and £25,500 for the PL1000 Plus with the same configurations, respectively.
Contact: Reflex Technology Ltd., 9 Buckingham Place, Bellfield Rd., High Wycombe, Buckinghamshire HP13 5HW, UK, 44-494-465907.
Inquiry 921.

Add Unix Functionality to Your Novell Workstation

Novell users can now add Unix functionality to their existing workstations with release 1.3 of CocoNet. CocoNet is an Ethernet LAN based on an industry-standard implementation of SCO Xenix-Net and Microsoft Networks, designed specifically to tie together 286- and 386-based personal computers running Unix, DOS, OS/2, and Novell.

The product lets users of Unix, DOS, OS/2, and Novell share resources such as files, disks, printers, tapes, and distributed processing power within a networked Unix, DOS, OS/2, and Novell operating environment. It consists of the Redirector, the Server, and several network utilities.

You install the Redirector in a workstation where it provides the transparent redirection of file and print requests from a local system to a remote system on the network. The Server is run as an application in a server machine and provides file and print services to the network. There are also utilities for virtual terminal log-ins, remote diagnostics, and system management.

Access to the network files is controlled via the Server's Unix security. You can assign user log-ins and passwords to a directory or its substructure, and this password is checked whenever a user attempts access. You can also assign an access mode to a directory, allowing permission to read only, write only, execute, or any combination of these, for the owner of the file, the owner's group, and all others.

Novell workstations can run server-based applications from the Novell or Unix server that transparently and simultaneously access files stored on either or both machines. CocoNet's new proprietary architecture allows a DOS workstation to run both a Novell shell (e.g., IPX or NET3) and the CocoNet NetBIOS Network (e.g., NetBIOS or Redirector) simultaneously with no additional DOS memory usage, if high memory is available.

Features include support for Ethernet, thin Ethernet, StarLAN, and twisted-pair Ethernet; peer-to-peer networking (all machines on the network can be servers or workstations); support for Interactive's 386 IX; new performance configuration utilities; expanded high-memory support; and a communication gateway from Novell/DOS through Unix to SNA 3270, Async, Bisync, TCP/IP, X.400, and X.25.

CocoNet 1.3 requires an IBM PC, XT, AT, or PS/2 Model 25 or 30; a 386 computer running Unix with 4 MB of RAM and 640K bytes of base memory; DOS 3.3; SCO Xenix 2.3; and Advanced NetWare 2.15.
Price: £1895 and up.
Contact: LAN Technology International Ltd., 111 Higham Rd., Rushden, Northamptonshire NN10 9DS, UK, 44-933-316486.
Inquiry 916.

continued

5 out of 5 hackers prefer other software protection methods to Hardlock E-Y-E®

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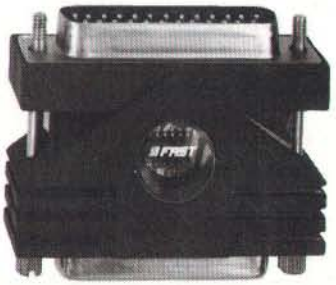
What your customers will like...
Hardlock E-Y-E allows unlimited backup copies. The device is shipped with the software for the user simply to plug into the parallel interface and forget.

Daisy chainability, outstanding reliability (no battery is needed), and the most compact High-Tech design ensure that your customer will accept Hardlock E-Y-E.

What your accountant will like...
Hardlock E-Y-E needs no factory coding. This ensures optimum delivery schedules and stock flexibility. Revenues will go up as software piracy and multiple usage are prevented. Despite its wealth of features, Hardlock E-Y-E's prices remain competitive.



Hardlock E-Y-E programmable, algorithmic response and memory option – all in one.

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For additional information, contact Brahim Ajari at Fast Electronic or one of the distributors listed below:

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Circle 422 on Reader Service Card (DEALERS: 423)

Circle 406 on Reader Service Card

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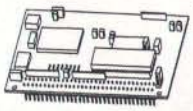

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Circle 461 on Reader Service Card

An EISA Network Interface Card

A new family of high-performance 4-/16-Mbps token-ring products from Proteon International features integrated support for unshielded twisted-pair (UTP) cabling. The ProNet-4/-16 family includes a token-ring adapter for the 32-bit EISA bus and a high-performance adapter for the IBM PC. The family also includes a new external media filter that allows IBM networks to take advantage of the simplicity of UTP cabling and a new network management software package called TokenView Plus.

The p1990 ProNet-4/-16 EISA Network Interface Card is a token-ring adapter that supports the EISA personal computer platform. Together with EISA-based computers, the new card will virtually eliminate file-sharing bottlenecks that can occur between the server and the interface. The card is software switchable between 4 and 16 Mbps, allowing you to install 4-Mbps networks and upgrade to 16-Mbps networks using the same card. It also supports UTP and shielded twisted-pair (STP), giving you the choice of the two popular network media options.

The p1990 supports Novell NetWare 386, as well as NetWare 2.15, Banyan VINES, Microsoft OS/2 LAN Manager, and IBM Networking Software.

The p1390 ProNet-4/-16 AT Network Interface Card provides IBM PC, XT, and AT workstations and file servers with a connection to 4-/16-Mbps token-ring networks. It features Proteon's bus master design, which maximizes system utilization, provides high performance, and transfers data more efficiently than non-bus-master adapters.

Like Proteon's EISA adapter, the p1390 is software selectable for 4 and 16 Mbps for easy configuration and built-in upgrade capability. Integrated 4-/16-Mbps UTP and STP support also gives the p1390 cabling flexibility. The p1390 also supports Novell NetWare 386, NetWare 2.15, Banyan VINES, Microsoft OS/2 LAN Manager, and IBM Networking Software.

Proteon's new p2906 ProNet-4/-16 UTP Media Filter provides an open environment for IBM 16/4 adapter users to take advantage of UTP networking, and its new TokenView Plus and TokenView Manager monitors and controls multiple ProNet-4/-16 and -10 networks.

TokenView Plus is a menu-driven software package that lets you monitor and manage the network from a single station. Network managers can use TokenView Plus with the Series 70 Intelligent Wire Centre (see May What's New International, page 64IS-30) to partition and isolate network problems and to reconfigure the system in 5 minutes or less, according to the company.

TokenView Manager communicates with TokenView Plus stations through the Novell IPX protocol (2.01 or higher).

Price: £750 for the p1990; £650 for the p1390; £150 for the p2906; £750 for TokenView Plus; £1500 for TokenView Manager.

Contact: Proteon International Ltd., The Business Park, Technology Dr., Beeston, Nottingham NG9 2ND, UK, 44-602-431311.

Inquiry 917.

continued

Why we developed a network for small business?

Unlike other LANs that try to make a sale out of complexity in the name of technical excellence, D-Link gives you the practical solution with product quality and solid performance that you can afford. Take our D-Link LANsmart network operating system software, for example. Its DOS and NetBIOS compatibility gets you right away into information/peripheral sharing with all existing applications available in the market. Its easy operating and flexible configuration features make it ideal for any small business that cannot afford the expenses of constant professional support and dedicated server computers.

From Ethernet to ARCnet to our own twisted-pair network, D-Link gives you the one-stop shopping convenience to select hardware to fit your specific requirements of networking PC/XTs, AT/386s and PS/2s together. All D-Link hardware also gives you an additional benefit: it not only runs our own LANsmart software but also is fully compatible with other major LANs, such as Novell's NetWare. Which makes your investment on D-Link even more valuable and long-lasting.

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Circle 418 on Reader Service Card

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With the DPX-725 AppleTalk LAN Extender, you can link AppleTalk LANs in buildings within line-of-sight into one continuous network.

An Infrared Link for AppleTalk LANs

Now you can link Macs and IBM PCs on AppleTalk LANs in different buildings within line-of-sight into one continuous network with the DPX-725 AppleTalk LAN Extender system. Based on a high-speed infrared optical data link, the system lets users in different buildings share files using networking software such as AppleShare, TOPS, or NetWare, and printers using standard Macintosh System software.

The system operates at data rates of up to 2 Mbps, supporting the LocalTalk data rate of 230,400 bps and the TOPS FlashTalk data rate of 768,000 bps. The DPX-725 is transparent to data, so you can quickly install it with no changes to software.

To install the DPX-725, you simply mount an infrared transmitter/receiver head unit on the rooftop of each building. Then you connect the rooftop units via a cable to a base unit in each building and plug the AppleTalk cable into each base unit.

The system is not limited to just two buildings—you can also use the DPX-725 to interconnect large campus-wide networks. The main requirements are that the network buildings be no more than 1 kilometer apart and that their rooftop units be in line-of-sight of each other.

Price: $A13,000 to $A15,000.

Contact: Dataplex Pty. Ltd., 7–9 John St., Lilydale, Victoria 3140, Australia, 61-3-735-3333.

Inquiry 902.

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Circle 442 on Reader Service Card (DEALERS: 443)

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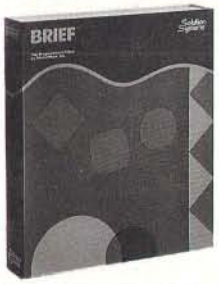

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Circle 453 on Reader Service Card

Print 450 Lines Per Minute

Mannesmann Tally has added a new model to its range of line printers that are designed for networks as well as system applications. The MT 645 is a hammer-bank line printer that can print at a speed of 450 lines per minute, which is ideal for printing listings, sets of forms, bar codes, special characters, and graphics.

Hammer-bank line printers have a row of parallel print elements called hammers. The hammers are kept in tension against a spring by a permanent magnet. To make a dot, an electromagnet weakens the permanent field just enough to let the spring push the hammer forward. In the next instance, the permanent magnet pulls the hammer back to its original position.

The MT 645 has four printer emulations: IBM Proprinter, Epson FX, Printronix P 600, and MT 660. You select the configuration via a key panel and a 16-character alphanumeric LCD panel. A view function feeds paper up to the view window so that you can monitor the entire page at any time while printing. By releasing the button, the paper returns to normal operation and continues where it left off. From the control panel, you can also perform diagnostic tests on motors, shuttle speed, serial port, and even minor adjustments to the shuttle position sensor and hammer-fire lead times. The integrated buffer allows up to a 27K-byte buffer space.

Five fonts are built in: data processing, Courier, Gothic, and OCR A and B. The MT 645 can print one original plus five copies. You get a choice of interfaces: RS-232C serial, Centronics or Dataproducts parallel, twinaxial, or coaxial.

The MT 645 line printer from Mannesmann Tally can print 450 lines per minute and has four printer emulations and five built-in fonts.

The paper-handling mechanism includes four adjustable pinfeed tractors with two above and two below the printed line. This ensures high-accuracy character placement in any application. A straight-through paper path ensures efficient form handling and easy form loading.

The MT 645 comes in desktop and pedestal configurations. An optional pedestal is available, as well as a quietized kit for printing at less than 55 dB(A).

Price: £3990; £450 for the pedestal; £500 for the quietized kit.

Contact: Mannesmann Tally, Molly Millar's Lane, Wokingham, Berkshire, UK, 44-734-788711.

Inquiry 911.

Omnis 5 for the IBM PC

Blyth Software offers Omnis 5 for the IBM AT and PS/2s, a database management system that is already available for the Macintosh. The program helps you develop business data management applications complete with run-time options and multiuser support.

You can build large data management systems with data files of up to 2560 MB, application files of up to 32 MB, and no limit on the number of records in a data file (up to the maximum data file size).

The event manager gives you complete point-and-click control over multiple open windows in a finished application, all with fonts, colors, and graphics.

Omnis 5 also supports Dynamic Data Exchange, which gives the software the ability to exchange data and send commands directly to other programs running on your AT. For example, Omnis 5 can transparently harness Microsoft Excel's graphics plotting ability to display database data.

The package also lets you include full-color graphics in the window design or store graphics in the data file, display text data in any font and color, include hot areas in graphics for transparent push buttons, display data from different files on any window, and substitute user-defined menus for the standard menus. In addition, Omnis 5 provides full support for graphics data; push-button, radio box, and check box field types; WYSIWYG reports; more than 200 programming commands; and variable-length records for efficient use of disk space.

Blyth Software has included its fast start program, Omnis 5 Express, in the package. Beginners can use Omnis 5 Express to help them with their first applications, while more-experienced users can use it for simple databases and fast prototyping of more-involved systems.

Omnis 5 requires an IBM AT or PS/2 with 640K bytes of RAM and 1024K bytes of XMS memory, Microsoft Windows 2.1, and a Windows-compatible printer. The program supports monochrome and color monitors and is compatible with leading networks like 3Com, Novell, TOPS, and PC AppleShare.

Price: £595 for the single-user version.

Contact: Blyth Software Ltd., Unitec House, 2 Albert Place, Finchley Central, London N3 1QB, UK, 44-1-346-9999.

Inquiry 951.

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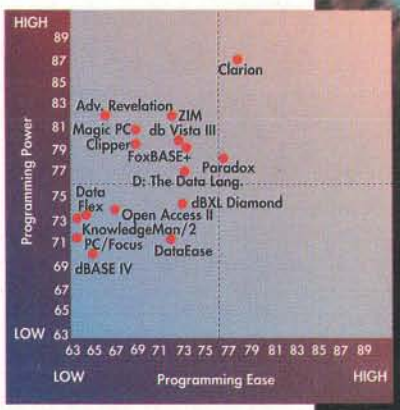
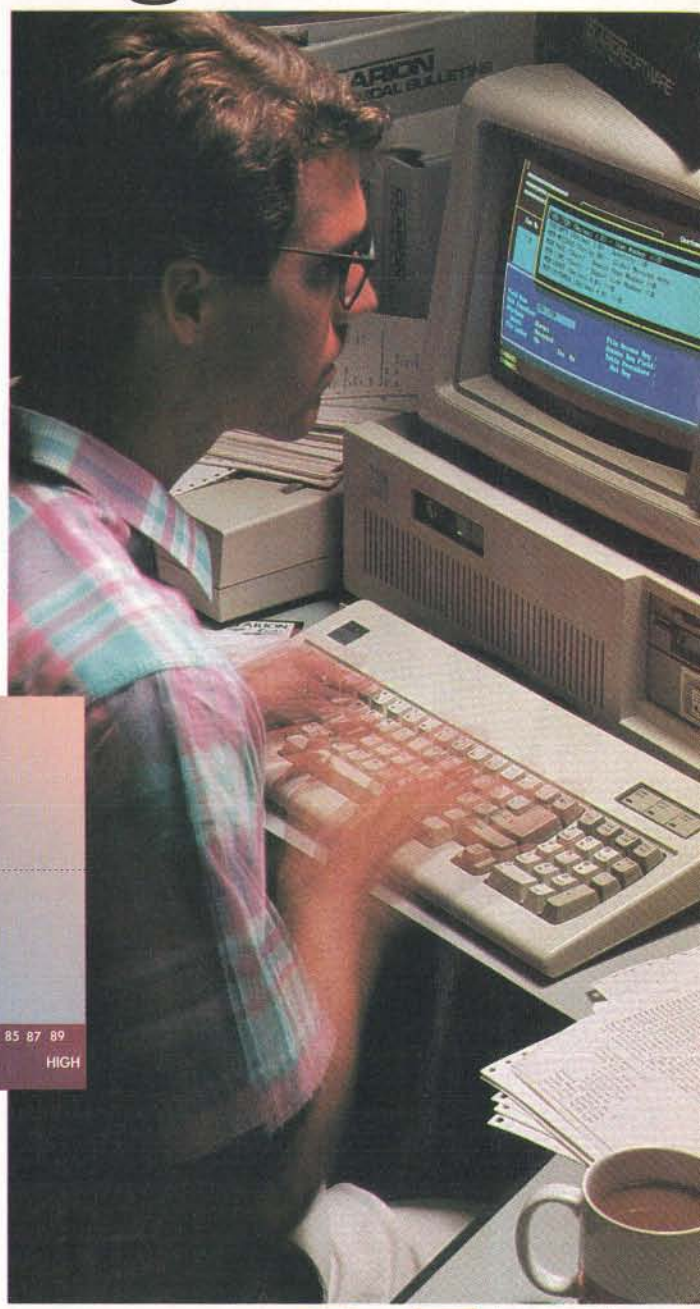


Here's what American corporations in a PC Week survey thought of the power and ease of use of Professional Developer vs. competitors. Any questions?



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Circle 412 on Reader Service Card (DEALERS: 413)

Varsity for Graphics and Image-Handling Applications

Varsity is Primagraphics' new modular workstation for graphics and image-handling applications. The workstation's RISC processor technology and open architecture offer a combination of high performance and flexibility.

Primabus, a multimaster synchronous bus, gives Varsity its speed—data transfer rates of up to 60 MBps and a throughput equivalent to 120 MBps over the VMEbus via its direct board-to-board DMA mode for block transfers. In addition, Primabus removes the bottlenecks often caused by mass data transfer, leaving the VME free for control tasks.

The heart of the new system is the Velocity RISC processor, which incorporates the AMD 29000 chip running at 25 or 30 MHz. The FPU, the 29027, gives you up to 7 MFLOPS peak in single or double precision, and a peak performance of up to 30 MIPS and 20 VAX MIPS. The Harvard architecture of the 29000 is supported by two on-board 120-MBps buses. Instruction memory is 128K bytes or 512K bytes of static RAM, which you can easily upgrade. A combination of SRAM and DRAM for the data memory gives high speed and large capacity. The data RAM size is 1 or 4 MB.

The Varsity modular workstation for graphics and image-handling applications from Primagraphics features a multimaster synchronous bus, a RISC processor card, a high-resolution display controller card, and an image memory card.

A full 32-bit VMEbus interface is implemented, with master, slave, interrupter, and interrupt handler. Configuration of the VME interface by software results in simple board setup and greater flexibility—you can use AMD's development tools, including the C compiler, the debugger, and the Adapt hardware tool. In addition, Primagraphics can supply a powerful graphics library for Velocity.

Venture is Varsity's high-resolution display controller. It provides an 8-bit framestore and color video output with a typical resolution of 1376 by 1072 pixels at a refresh rate of 60 Hz. The card gives you a possible fill rate of 240 million pixels per second with an 8-bit image.

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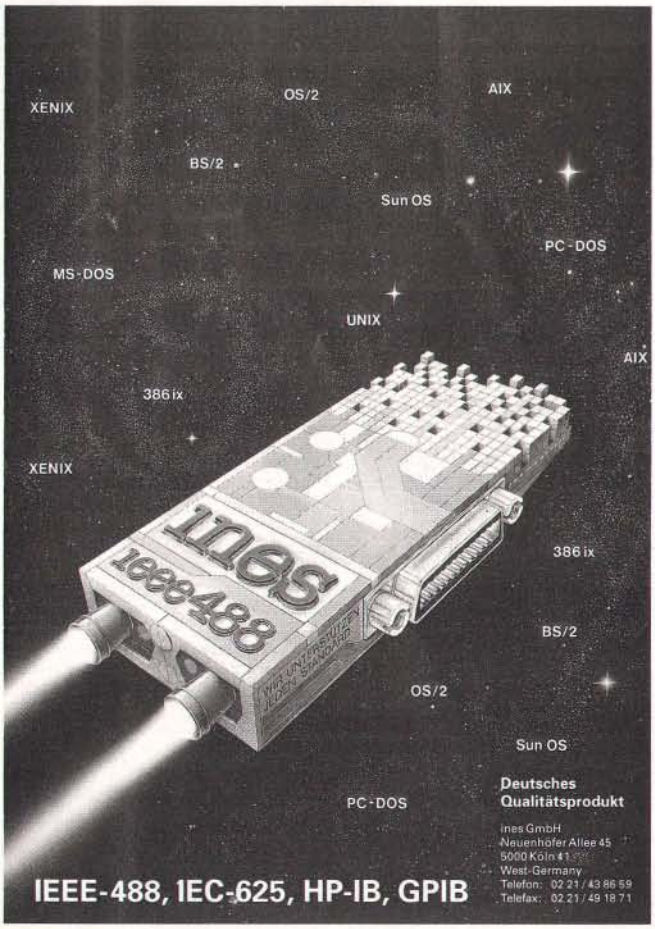


The image memory card for Varsity is called Viceroy. It provides a high-density memory array of from 4 to 64 MB and offers fast data transfer capability. An optional funnel shifter lets you align data to any bit position, permitting automatic realignment of stored images with no reduction in data rates. An onboard DMA controller provides direct data transfer via Primabus to any display controller or other memory card.

Primagraphics also offers Primalib, a graphics library for the Varsity system. Primalib supports a wide range of hardware environments, including single or multiple processors (up to seven Velocity processors), multiple display screens, and VME or Primabus. It provides fast image drawing and manipulation, with write enables and logic modes for all operations. When you use Primabus with a development kit, you can create C-language programs that you can add to the library's functionality.

The C-language library runs under Unix or stand-alone dedicated hardware. It supports memory-based bit maps of any size. Primalib comes in object-code format, with sufficient source code to let you add to the functionality. It provides access to the hardware facilities of Varsity modules, including specialized TV image-capture routines, hardware cursors, hardware panning, color-table manipulation, simultaneous multipixel update, bit-shift from image memory, burst mode and DMA on Primabus, and block transfer on VMEbus.

Varsity is available with 5¼-inch floppy disk drives, 105- to 640-MB hard disk drives, and a 60-MB tape streamer.

Price: £15,000 to £90,000 for Varsity; £6500 and up for Velocity; £4000 and up for Venture; £2500 to £18,000 for Viceroy; all prices depend on the configuration.

Contact: Primagraphics Ltd., Melbourn Science Park, Melbourn, Royston, Hertfordshire SG8 6EJ, UK, 44-763-262041.

Inquiry 945.

Calendar Calculations under Turbo Pascal

With the DateCalc Turbo Pascal library, you can solve the following calendar calculation problems: determine the distance between two given dates in units of years, months, weeks, days, or workdays (absolute or relative); check a date for plausibility; determine week numbers; perform various ultimo calculations; determine a year's, month's, ultimo's, or day's properties; add months, weeks, days, or workdays to a given date; determine a week's first and last day; and determine all holidays of a year or month.

All the functions signal errors (e.g., out-of-range dates) by setting an error code. The calculations are not implemented by simple table lookups; instead, DateCalc has built-in algorithms reflecting the complex circumstances and properties of time measurement.

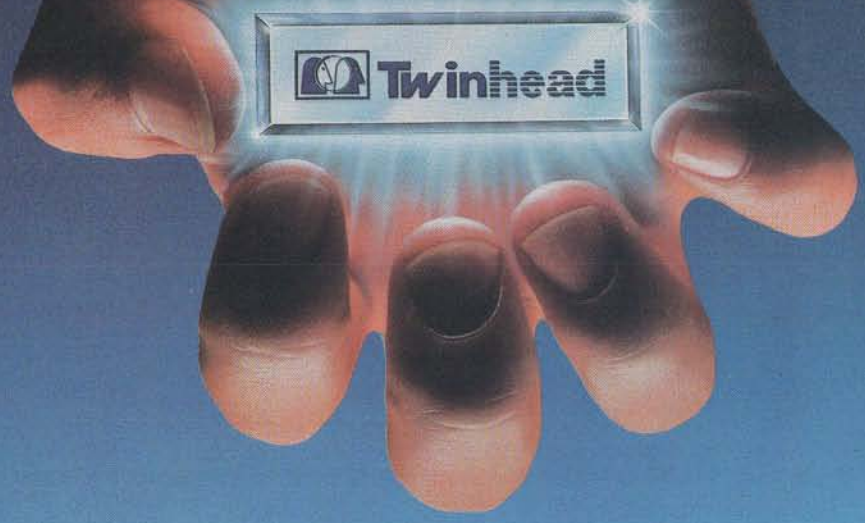
DateCalc runs under Turbo Pascal 4.0 or higher and comes with full Turbo Pascal source code. The product uses West German calendar rules and has German documentation.

Price: 198 deutsche marks.

Contact: O.K. Soft, P.O. Box 945, Posener Strasse 36, 2940 Wilhelmshaven, West Germany, 49-44-21-5-20-02.

Inquiry 922.

continued



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A compact platform for fast 386 or 486 processing. The basic 600 (386-25MHz) is slotted for simple Power Card upgrades. Power Cards supply CPU (386-25/33, 486-25/33), 64KB cache, and cache controller. All-in-One design integrates VGA, parallel and 2 serial ports, and drive controllers on mainboard. Storage for 2 × FDDs, 3.5″ HDD, and 5.25″ Tape/HDD. Superset-600 is your bridge to the future.

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Trademark Recognition:
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International Business Machines Corp.: VGA
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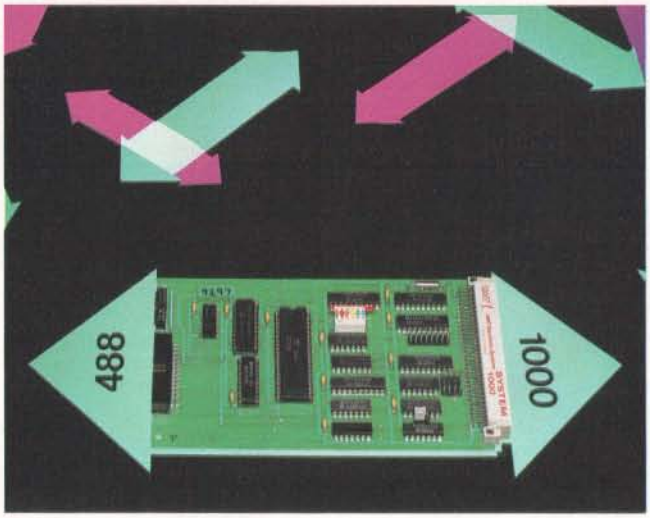
Circle 463 on Reader Service Card

Interface STEbus Systems with IEEE-488 Networks



The GMT-1070 is a talker, listener, or controller card that allows an STEbus system to interface with IEEE-488 networks.

The GMT-1070 from GMT Electronic Systems is an STEbus slave card that lets you interface an STEbus system with an IEEE-488 general-purpose interface bus (GPIB) network.

The half-size card includes a 7210 intelligent controller chip, GPIB receiver/driver circuitry, eight read and eight write registers accessible to the STEbus, and a bank of LEDs to indicate GPIB status.

The GMT-1070 can act as a talker, listener, or controller on the GPIB. To ensure ease of connection, there's a 26-way insulation displacement connector on the front edge of the card, with signals arranged in such a way that a ribbon cable can neatly interface with an IDC-to-GPIB connector so you can use standard GPIB connectors.

On the STEbus side, the card can generate two signals: One is an interrupt request that comes into action on any one of 13 specified GPIB statuses; the other is a DMA request allowing fast data transfers between the card and system memory.

You use a set of user-configurable switches to determine whether the card acts as a GPIB controller and to set the device address on the GPIB.

The 16 registers accessible to the STEbus include data I/O, interrupt status and mask, and serial poll status and mode. These can reside at any 16-byte boundary in the STEbus I/O page, under jumper selection.

Price: £167.

Contact: GMT Electronic Systems Ltd., 7 Mole Business Park, Leatherhead, Surrey KT22 7BA, UK, 44-372-373603.

Inquiry 925.

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After years of experience in manufacturing OEM controller boards and talking to customers, we think we have hit upon just the right combination of format and function to satisfy even the toughest case of "relay mentality." Realizing that not every computer/controller application warrants a Cray X/MP, Micromint offers a tiny 8031/8052-based controller board for those dedicated and cost-sensitive installations.

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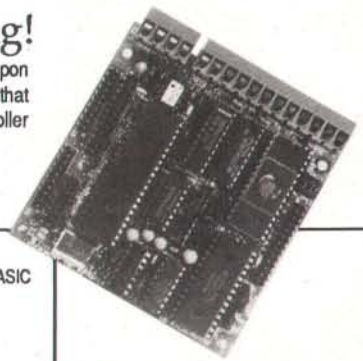

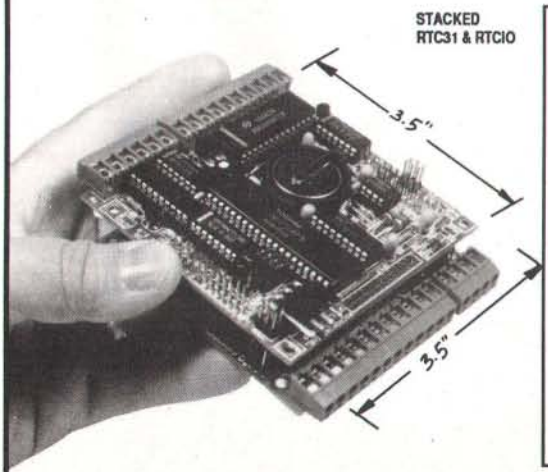

RTC31 and RTC52 Technical Specifications
- 8031 processor (RTC31) or Micromint 80C52-BASIC processor (RTC52)
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RTC52-1 80C52 Controller	**£105**
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- DC to DC conversion—5-volt-only operation
- Screw terminals or quick disconnects
- Small 3.5"x3.5" format

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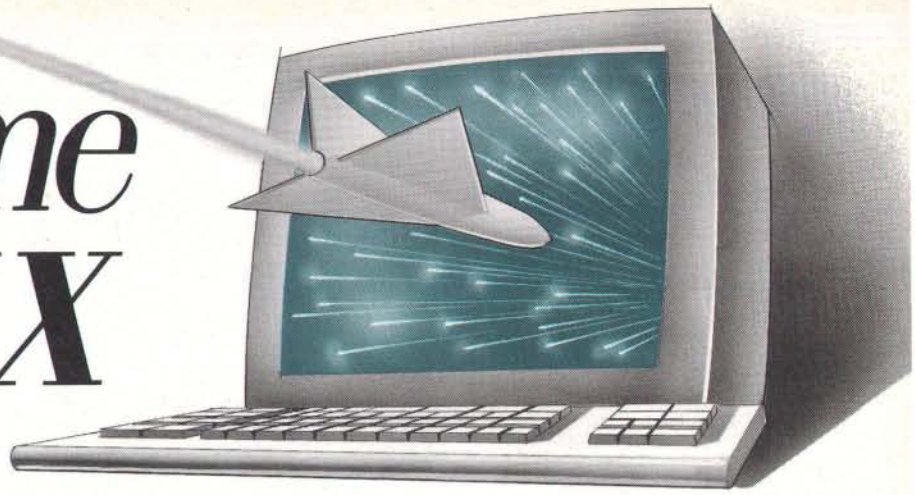

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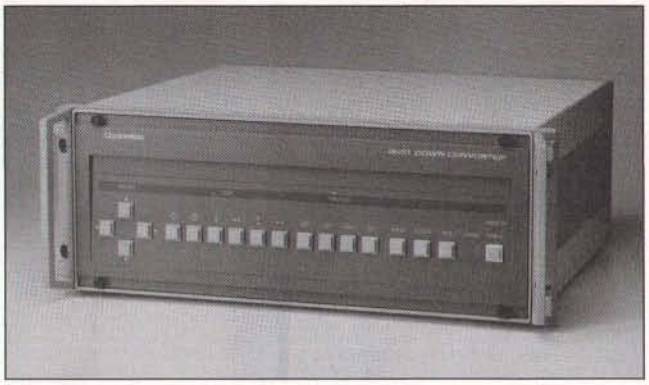
You can use Chromatek's Down Converter Model 9120 to convert high-resolution video signals like computer graphics to broadcast-standard TV format (NTSC and PAL). The device can accept input from 15 to 128 kHz.

You can directly connect personal computers, workstations, and graphics stations to the Model 9120. When you input a video signal to the Model 9120, it automatically measures it, refers the results to a built-in data table, and defines the manufacturers, models, and modes of workstations that generated the video signals. When the input scanning standards are not found in the data table, the Model 9120 infers a standard from the measured scanning standards and automatically establishes a proper conversion procedure.

The Model 9120's zoom function has three modes: H mode is for outputting a specific area of an input picture; N mode is for outputting an entire input picture by compressing it; and L mode is for outputting a further-compressed entire input picture on a part of a screen. You can use the zoom function to magnify an image from ×0.25 (the minimum magnifying power of the L mode) to ×16 (the maximum magnifying power of the H mode). The zoom operates in real time, and a built-in two-dimensional filter is automatically set to the constant corresponding to magnifications.

You can choose NTSC or PAL as output and use the Model 9120 for either one by simply changing the encoder unit. The encoder unit has an image-enhancing circuit; a montage circuit for making a composite picture from an external broadcast signal and an output video signal from the 9120; and a genlock circuit for matching the phases of a synchronous signal and an output synchronous signal from the 9120.



Chromatek's Down Converter Model 9120 lets you convert high-resolution video signals to broadcast-standard TV format signals.

Other built-in functions include a chroma key option for producing a composite picture with a simple operation; a PG option for producing color bars, test patterns, and a leader film; and a D1 format option to correspond to digitized broadcasting studios.
Price: 2,650,000 yen.
Contact: Chromatek, Inc., Video Technology Lab, KSP-C-1232, 100-1 Sakado, Takatsu-ku, Kawasaki-shi, Kanagawa 213, Japan, 81-44-819-3477.
Inquiry 909.

A Portable with CD-ROM Drive

Comcen Technology's CD-Portable is an IBM AT compatible with a Hitachi CD-ROM drive, a high-resolution VGA plasma display, and a 40- or 100-MB hard disk drive.

The machine also comes with a 16-MHz 286 CPU, 1 MB of RAM, a 3½-inch 1.44-MB or 5¼-inch 1.2-MB floppy disk drive, one Centronics parallel port, one RS-232C serial port, an external VGA port, and a mouse. The supplied operating system is DOS 3.3.

Comcen Technology also offers CD-Server, a 386SX-based CD-ROM file server that provides network access to CD-ROM databases. It is compatible with NetBIOS-based network operating systems such as 3Com, Novell, and LAN Manager.

Up to 100 users on the network can access the CD-ROM database simultaneously. You load the Opti-Net software supplied with CD-Server on top of the networking software, and it provides the network interface to the CD-ROM drive. You can install one or two internal CD-ROM drives into CD-Server, with up to six more drives connected externally.

CD-Server's basic configuration includes a mini-tower 386SX CPU, 2 MB of RAM, a 3½-inch 1.44-MB floppy disk drive, a 40-MB hard disk drive, an internal CD-ROM drive, a monochrome graphics adapter and monitor, a NetBIOS network interface card, one RS-232C serial port, one Centronics parallel port, an IBM AT–compatible keyboard, and an Opti-Net license for one to 100 users.
Price: £3495 to £4495 for the CD-Portable; £3995 for the CD-Server.
Contact: Comcen Technology Ltd., 45/51 Wychtree St., Morriston, Swansea SA6 8EX, UK, 44-792-796000.
Inquiry 908.

Access Networked Mainframes and Workstations

Tenset/TCP lets you access the resources and power of networked mainframes and workstations from your DOS computer. You can access TCP/IP facilities, such as file transfer, remote log-in, remote printing, and E-mail, on local networks and (via gateways) remote networks.

The product runs on DOS 2.0 or higher and is fully compatible with Microsoft Windows. Tenset/TCP will also coexist with Novell NetWare, so you can simultaneously use NetWare and Tenset/TCP on the same network and on the same machine.

You can configure Tenset/TCP for a variety of hardware—industry-standard packet-driver interfaces allow it to work with various network adapters with only a small memory overhead. You can use Ethernet or serial lines for the communication hardware, including dial-up lines. Tenset/TCP currently provides packet drivers for the NI5010, NI5210, 3C501, 3C503, 3C523, and WD8003E Ethernet adapters and for serial cards based on the Intel 8250. In addition, Tenset/TCP will work with other hardware that comes with a packet driver.

Tenset/TCP runs on an IBM PC with 256K bytes of RAM.
Price: £295.
Contact: Tenset Technologies Ltd., Norfolk House, 301 Histon Rd., Cambridge CB4 3NF, UK, 44-223-328886.
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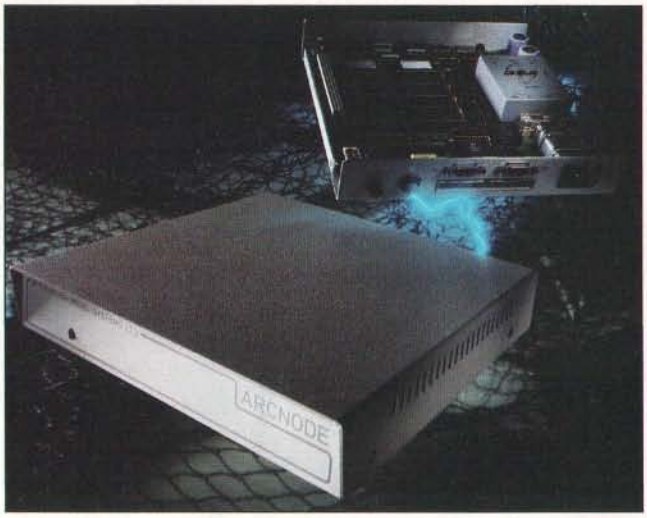

ARC-Node is a 68000-/68010-based single-board computer that includes two RS-232C serial ports, a 20-bit parallel port, 256K bytes of RAM, 128K bytes of ROM, an ARCnet interface, and an internal bus expansion adapter.

An Intelligent ARCnet Node

An intelligent ARCnet node, Windrush Micro Systems' ARC-Node is a small, self-contained 68000-/68010-based single-board computer that includes two RS-232C serial ports, a 20-bit parallel port, 256K bytes of RAM (expandable to 1 MB), 128K bytes of ROM (expandable to 256K bytes), an ARCnet interface, and an internal bus expansion adapter.

You can use ARC-Node as a remote, reconfigurable, intelligent I/O controller; for remote, diskless workstations; as a crash-resistant workstation with local I/O; for distributed processing where a master server is in control of several remotes, each running a local program; as a data and peripheral concentrator that provides an ARCnet interface for laser printers, modems, and so on; and for remote terminal access to a master/server (up to 2000 meters away).

ARC-Node is available in a variety of configurations. It comes in a compact, small-footprint (9- by 9-inch) unit that consumes only 18 W of power.

Price: £935 and up.
Contact: Windrush Micro Systems Ltd., Station Rd., Worstead, North Walsham, Norfolk NR28 9SA, UK, 44-692-404086.
Inquiry 957.

ASP Products for the NeXT Computer

ASP has developed its X-Final screen editor and RT-Prolog language-processing system for the NeXT Computer.

X-Final uses the NeXT sound-sampling mechanism for voice help and operation advice functions, while RT-Prolog is a Prolog interpreter that minimizes processing terminations to garbage collection. The NeXT version will provide programs created with the interface builder, and interprocess communications libraries, at the Prolog description level.

Price: 98,000 yen each.
Contact: ASP, Ohta-ku, Tokyo, Japan, 81-03-767-1451.
Inquiry 1129.

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High-Performance Modems for Leased Lines

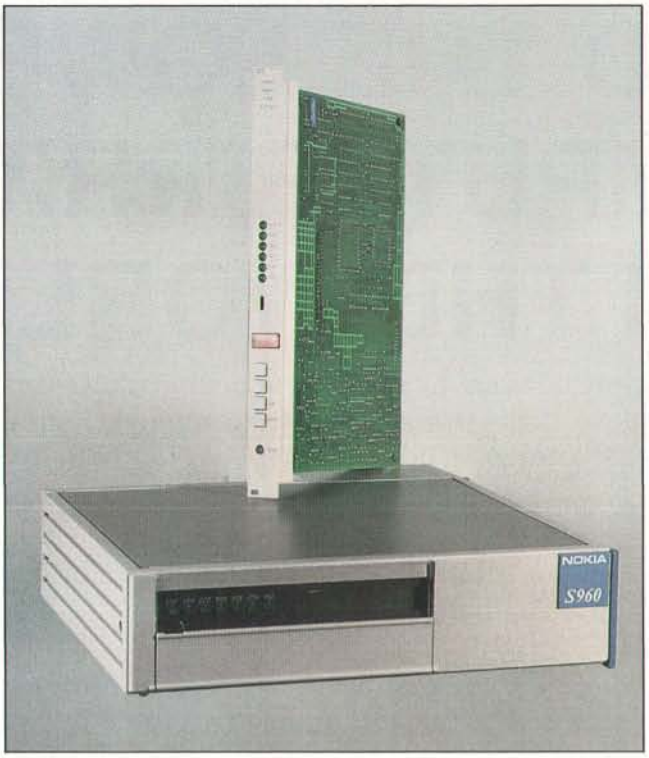
The S-series modems from Nokia Data Communications combine high-speed data transfer from 2400 to 14,400 bps with efficient network management over multipoint and point-to-point connections. The S960 and S1440 modems are available in stand-alone and rack-mounted versions. You can install the rack-mounted versions into a standard Nokia subrack system.

The modem protocol, Link Problem Determination Aid-2 (LPDA-2), allows the modems to achieve complete remote control of the modem/line/DTE interface environment. It includes three modem diagnostic commands: line analysis, modem and line status test, and transmit/receive test. The configuration commands check modem parameters, while the operation control commands include data rate and dial backup control functions.

The standard connection is a single-port, four-wire synchronous leased-line connection, but several other options are also available, including a modem-sharing function and dial backup operation over switched lines. In multipoint networks, the S-series modems offer fast poll operation with 14-ms RTS-CTS delay and automatic adaptation to the changing data rates and RTS-CTS delays.

In addition to the network management functions, the S-series modems offer functions that you can control manually via the front panel. You can also control the remote modem from the front panel.

The Nokia S960 is a high-performance leased-line modem for demanding data-communication networks. It offers high-speed data transfer operation from 2400 bps to 9600 bps, and it also manages the entire modem environment under the control of host-based network-management software, such as IBM NetView and Cincom Net/Master.



The Nokia S960 modem offers data transfer operation from 2400 to 9600 bps on leased lines.

The Nokia S1440 is also a leased-line modem for data-communication networks. It offers high-speed data transfer operation from 2400 bps to 14,400 bps and, like the S960, can manage the modem environment under the control of IBM NetView or Cincom Net/Master.

Price: About £2000 to £3000.

Contact: Nokia Data Communications, P.O. Box 122, SF-00381 Helsinki, Finland, 358-0-5671.

Inquiry 906.

PC World Forum/Moscow

PC World Forum, scheduled for July 10–15 in Moscow, will feature Soviet software developers with international vendors and development experts. Exhibitors will include IBM, Microsoft, Ashton-Tate, and Oracle.

A Software Development Conference will be held during the exposition. Among the speakers will be Bradley Homes, director of the U.S. State Department's Bureau of International Communications and Information Policy; Bernard Vergnis, vice president of Microsoft Europe; and Esther Dyson, consultant and editor of *Release 1.0*.

Contact: International Data Group, 5 Speen St., Framingham, MA 01701, U.S.A., 0101-508-875-5000.

Inquiry 886.

A Token-Ring Terminal Network

The Lightdata Terminal Server Network (TSN) lets you connect more than 1000 RS-232C serial devices and share them. The system consists of Serial Access Units (SAUs) that can accept up to four asynchronous interface cards to provide 32 RS-232C connections. The LNET bus connector connects the card to the SAU bus, and the other connector passes all RS-232C signals through to the appropriate backpanel. A single ring can accommodate up to 100 SAUs, and you can implement even larger systems by interconnecting multiple rings. The system can act as a stand-alone network or coexist on a ring with existing token-ring applications and products.

The SAU Processor Card is based on a Motorola 68000 microprocessor with a clock speed of 12 MHz. The card has a 64-way bus edge connector for connection to the custom-designed high-speed LNET bus used in the SAU. You use a pair of rotary switches to select the SAU index number, which the manager also uses to reference the SAUs on a network. You program the other parameters of the SAU remotely at the manager node.

After you attach an SAU to a network, you connect each device dynamically according to information supplied by the network manager and stored on the manager node, which can be any IBM PC with 512K bytes of RAM, a monitor, a keyboard, a single floppy disk drive, and a Lightdata Token Ring Card. You can connect an RS-232C serial device across the ring to

continued

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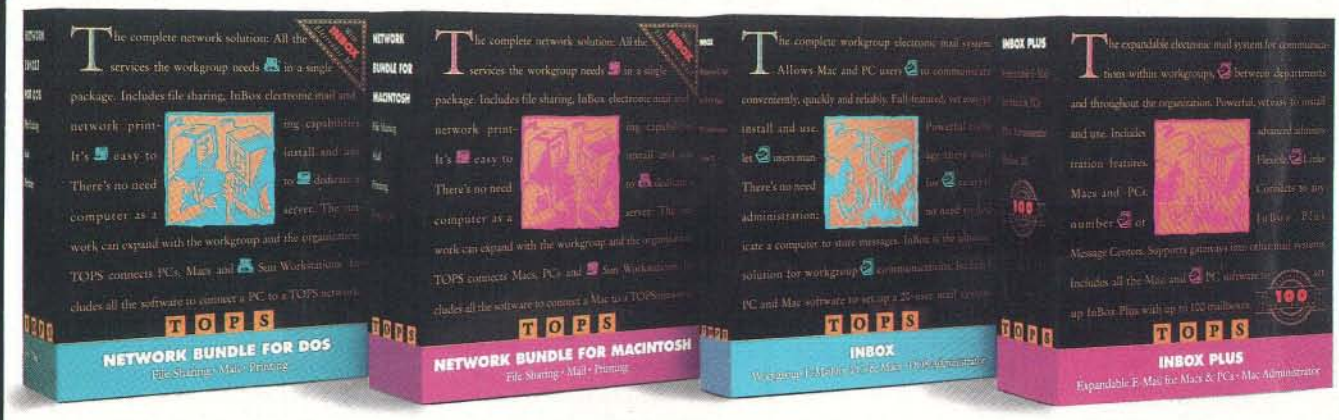

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WAIT STATE	0 WS ON CACHE READ.
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another RS-232C port, or you can set it up so that when you press any key the device passes a message to the PC, where it accesses a lookup table and establishes the connection. The lookup table held in the PC lets you map ports on a one-to-one basis or pass a request on to one of a group of ports. Ports are timed out after a period of inactivity.

The software runs in background mode (nondedicated communications server). You can access and modify the database of information using a custom-designed pop-up window user interface, which also provides monitoring facilities for node and ring activity. An optional stand-by node automatically takes over the manager functions in the event that the manager node fails.

For installations that require a very high total throughput, you can replace the 4-Mbps token-ring cards with 16-Mbps cards. The company offers fiber-optic interfaces and cabling (Type 5) as an alternative to the normal copper cabling (Type 1).

One SAU rack includes a backplane, a power supply unit; a processor card; a 4-Mbps token-ring card; an asynchronous serial interface card and back panel (8 ports); an internal passive multistation access unit; an internal cable harness; and a fan.
Price: £2495 for one SAU rack; £395 for an Asynchronous Serial Interface Card (8 ports) and backpanel; £875 for a 16-Mbps Token Ring Card for SAU (upgrade); £395 for an 8-bit 4-Mbps Token Ring Card for the IBM PC; £780 for an 8-bit 16-Mbps Token Ring Card for the IBM PC; £995 for the Network Manager Software (per network).
Contact: Lightdata Fibre Optic Communications Ltd., The Q.E.D. Center, Main Ave., Pontypridd, South Wales CF37 5YR, UK, 44-443-841454.
Inquiry 907.

Vector and Array Processing Libraries

S.M.I.S. has created a new set of Vector and Array Processing Libraries for its range of floating-point Vector 32C cards for the IBM AT (see What's New International, June 1989, page 96IS-38). The Libraries provide more than 100 functions for signal-, image-, and array-processing applications, such as trigonometric, logarithmic, filter, and matrix operations, and one-, two-, and three-dimensional fast Fourier transforms. You can use the libraries to accelerate your signal-and array-processing applications and to implement a range of functions without extensive programming requirements, according to the company.

The optimized microcode subroutines reside on the Vector 32C cards, and you call them from a choice of Microsoft C, Microsoft FORTRAN, Turbo C, or Turbo Pascal. You can use the library functions without becoming involved in the details of the hardware, so application development can begin immediately and be completed quickly.

You can extend the Vector and Array Processing Libraries with your own subroutines, which you can create by using an optional C-like assembly language package.

The Vector and Array Processing Libraries require DOS 3.1 and the appropriate language compiler.
Price: £795.
Contact: S.M.I.S. Ltd., Alan Turing Rd., Surrey Research Park, Guildford, Surrey GU2 5YF, UK, 44-483-506611.
Inquiry 944.

continued

 Circle 427 on Reader Service Card

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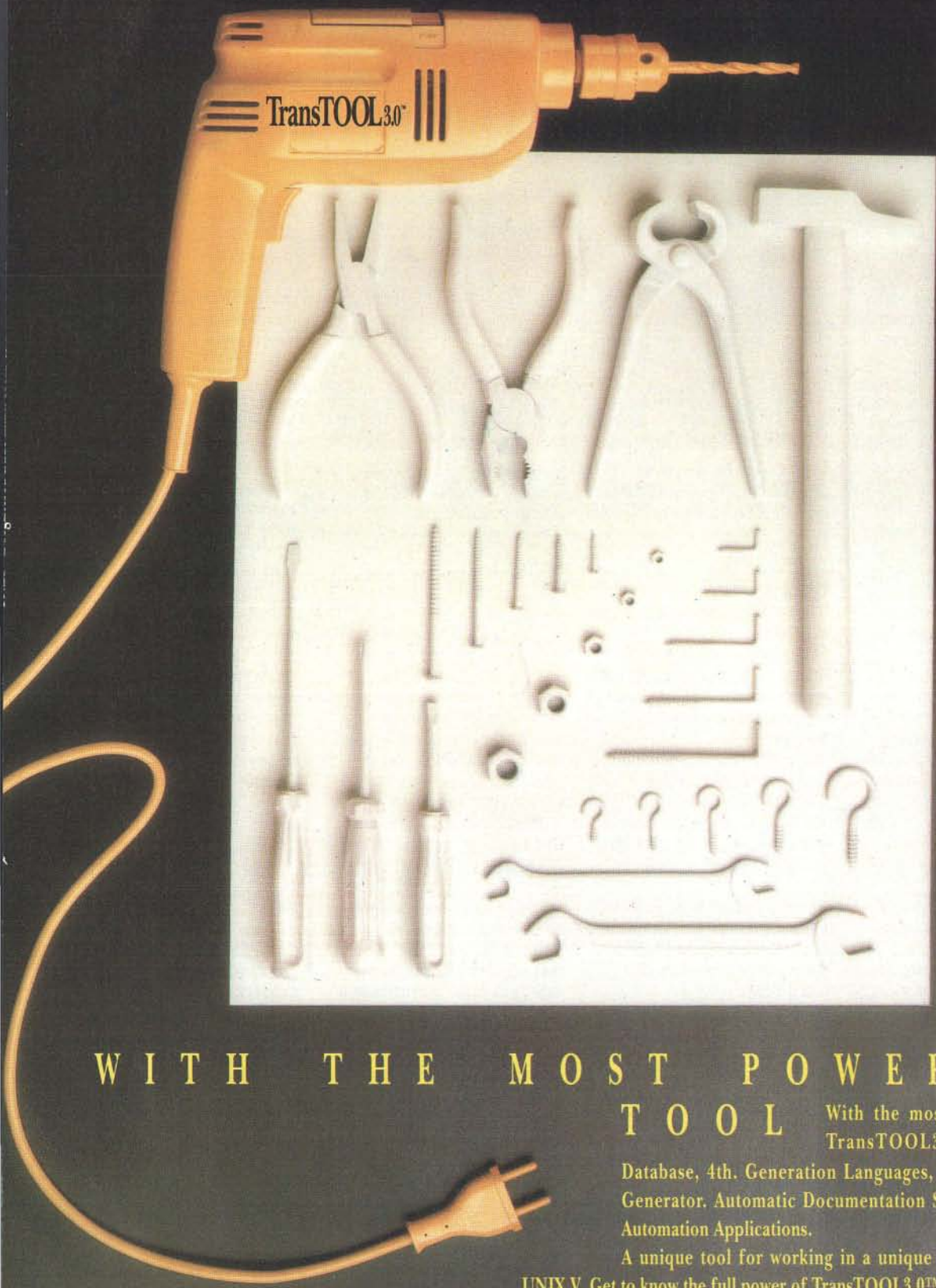
WORK IN UNIX-V



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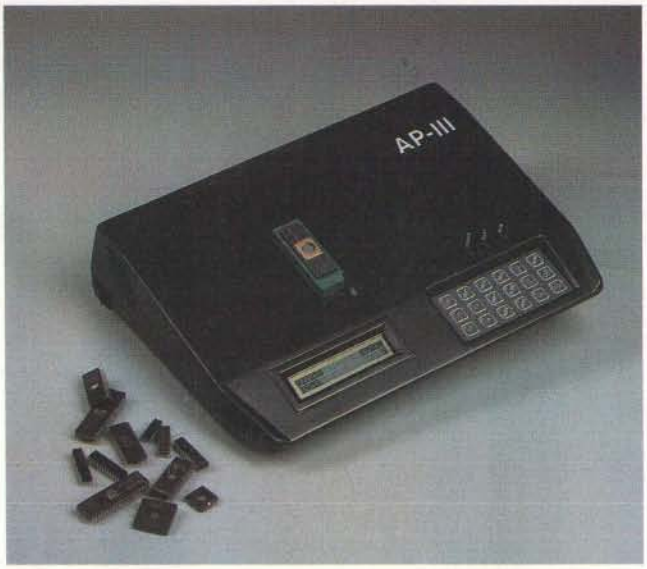
The AP-III intelligent universal programmer from Owen Electronics lets you program the following device families without any additional modules or adapters: EPROMs, EEPROMs, bipolar PROMs, MCUs (microcontroller units), EPLDs (electronically programmable logic devices), PALs (programmable array logic devices), GALs (generic array logic devices), and PEELs (programmable electrical erasable logic devices). The programmer can burn 7-ns PALs, 10-ns GALs, Flash E(E)PROMs, and 2- and 4-Mb EPROM devices with 8- and 16-bit data buses.

The device has a high-speed RS-232C communication interface that works with a transfer rate of 115,000 bps, which reduces downloads that are normally extremely long to an acceptable time delay, according to the company.

You can operate the AP-III in stand-alone mode and in remote mode. If you run it in stand-alone mode, you input all basic functions like program, read, verify, blank, device select, and edit through your keyboard. Additional functions include shuffle addresses with memory devices, buffer start, buffer end, device start, and security fuse on/off when programming PLDs. In remote mode, a menu-driven software package for DOS systems lets you work efficiently with the programmer.

The Device functions include a library of manufacturers and devices; the Files functions activate all file and directory functions, which you normally find only in the operating system; and the Options functions contain optional settings such as Split (8-/16-/32-bit), Assemble PAL/ GAL, Pinout for PALs/ GALs, and Read/Write Setup. The Edit functions include two editors, one for ASCII text files and one for EPROM Dump files, while the I/O Device functions implement the program, blank, read, and verify functions.



With Owen Electronics' AP-III, you can program EPROMs, EEPROMs, Bipolar PROMs, MCUs, EPLDs, PALs, GALs, and PEELs without additional modules or adapters.

An LCD maintains all outputs and the AP-III uses a 16-bit MCU with up to 4 Mb of RAM to be able to program 4-Mb chips. A battery backup holds all important data and parameters.

Price: 5498 deutsche marks.
Contact: Owen Electronics GmbH, Ringstrasse 11, 6798 Kusel, West Germany, 49-6381-5085.
Inquiry 942.

Analyze Uncertainty and Risk

Predict! is a spreadsheet-based modeling and simulation tool that helps you analyze uncertainty and risk. It combines the power of a sophisticated modeling tool with the flexibility, familiarity, and ease of use of a spreadsheet.

You can use the package's techniques for applications such as sales forecasting, market share estimating, capital investment appraisal, credit analysis, queuing simulation, inventory planning and control, and natural resource exploration.

Predict! uses probability and statistical techniques. Each cell in a Predict! model can describe uncertain behavior using eight standard probability distributions, or you can define your own. You can use these distributions to incorporate "gut-feel" estimates into your model or to describe a wealth of raw data. Once you have described a situation's uncertainties using distributions, Predict! automatically simulates the model using the Monte Carlo method, performing a potentially infinite number of "what-ifs," each one weighted for how likely it is to arise.

Once you have built up the required store of results, you can examine these output distributions using Predict!'s interpretive facilities. You can draw graphs to see the variability of distributions you are interested in, or read off the chance of obtaining outcomes around a chosen value, or find a value you can be confident of achieving, and so on. You can then interrelate and compare with other distributions in the model.

You can obtain more precise information about a distribution by carrying out statistical analysis—for example, you can perform functions such as standard deviation, percentile, mean/median/mode, chi-square statistic, and maximum/minimum.

Predict! also lets you glean other information from the model by performing sensitivity analysis to discover which items in the model your resultant variables are sensitive to.

You can present your information in up to 10 sets of data. The package supports graph types including x,y line graphs, scatter graphs, cumulative probability distribution graphs, continuous probability distribution graphs, discrete-valued probability distribution graphs, bar graphs, and stacked bar graphs.

Predict! requires an IBM PC with 512K bytes of RAM, DOS 2.1, and a graphics adapter. It will also run with the following system options: an expanded memory card that supports EMS, a math coprocessor, and a variety of graphics devices.

Price: £1460 for PC Predict!; £2440 for Transputer Predict!.
Contact: Risk Decisions Ltd., 27 Park End St., Oxford OX1 1HU, UK, 44-865-727025.
Inquiry 959.

continued

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A Multiprocessing Extension Kit for Smalltalk/V

According to Computas Expert Systems, the CX Multiprocessing Extension Kit brings out the full power of multiprocessing in Smalltalk/V 286 and Smalltalk/V. The Kit consists of 15 modules, totaling 600K bytes of reusable Smalltalk/V code, plus multiprocessing extensions (e.g., a process status window, the ability to update partly occluded windows, event scheduling, process communication primitives, and a data acquisition protocol) and environment extensions (e.g., a form inspector, a snap window facility, enhancements to the built-in drawing package, text-editing accelerators, text wrapping, menu-based access to previous method sources, and the ability to browse arbitrary large files in the disk browser).

The modules include CX Process Extensions, CX Semaphore Extensions, CX Process Status Window, CX Screen Controller, CX DateTime Functionality, CX EventQueue Mechanism, CX Acknowledge Mechanism, CX Data Acquisition Protocol, CX General Extensions, CX Form Inspector, CX FreeDrawing Extensions, and CX TextEditor Extensions.

The CX Process Extensions module gives you general extensions to the multiprocessing functionality, such as the ability to bind variables in processes, change the priority level range, and name processes. The CX Semaphore Extensions module provides extensions to the built-in process communication and synchronization primitives. The CX Process Status Window module lets you monitor and manipulate the processes and semaphores in the multiprocessing environment, and the CX Screen Controller module allows background processes to continually update the visible parts of partly occluded windows, preventing overlapping windows from being overwritten.

The CX DateTime Functionality module simplifies the expression of temporal relations and reasoning, especially for intervals spanning midnight. You also get string conversion methods and various rounding methods and prompters. The CX EventQueue Mechanism module lets you schedule evaluations of Smalltalk/V expressions along the time axis, while the CX Acknowledge Mechanism module facilitates interaction with the user from background processes.

The CX Data Acquisition Protocol module provides a Smalltalk/V interface to the μMAC-4000 controller from Analog Devices, including automatic handling of errors on noisy communication lines. For other similar measurement and control systems, you can use this protocol as a template. This module requires the Communication Kit from Digitalk.

The CX General Extensions module contains new methods, primarily for String and Collection classes. The CX Form Inspector module gives you a choice of contents or fields when inspecting Form objects, and the CX FreeDrawing Extensions module provides extensions to FreeDrawing that make it more suitable for practical work. You get an undo mechanism, various control key accelerators, and the ability to store to and retrieve from disk. The CX TextEditor Extensions module provides additional control key accelerators, changes in the find and

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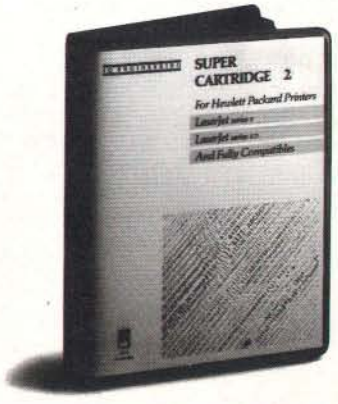

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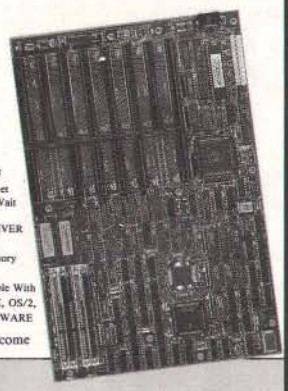

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replace behavior, and text-wrapping capabilities.

The CX Multiprocessing Extension Kit for Smalltalk/V requires an IBM XT and 512K bytes of RAM. The kit for Smalltalk/V 286 requires an IBM AT 286 or 386 and 1 MB of RAM (2 MB is recommended). Both kits also require a graphics adapter, DOS 2.0, and the Goodies #1 Application Pack from Digitalk. The company recommends a Microsoft-compatible mouse.

Price: US$99.95.

Contact: Computas Expert Systems A.S, Veritasveien 1, P.O. Box 410, N-1322 Hovik, Norway, 47-2-47-78-22.

Inquiry 905.

Manage Your Plant

Plant Monitor provides plant management facilities for distributed industrial implementation and control schemes. You can use the package's set of utilities to gather, monitor, record, archive, and display data; to supervise and act on alarms; and to network.

The package has a menu-based, mouse-driven, color graphics interface with help screens. You can choose Plant Monitor's standard mechanisms to display data, which include tabular and graphic formats, or you can construct custom displays or mimic diagrams using an integrated graphics package.

You can implement links to outstations, such as STEbus-based data acquisition and control systems, programmable logic controllers, robots, or numerical controllers, using serial communications or the twisted-pair Bitbus LAN; you can link to other PCs or higher-level supervisory computers via high-level networks such as ARCnet or Ethernet using optional plug-in expander boards.

In addition to automated supervision of and response to alarms, Plant Monitor's monitoring capabilities help you optimize plant/process management and quality. Using mimic displays, for example, you can display plant status in an instantly understandable form, providing trend information that helps you spot problems as they develop. You can also generate reports of process operation conditions for detailed analysis or permanent record requirements.

Plant Monitor's alarms management utility lets you program limits on every channel. It automatically logs transitions in and out of the alarm limits onto the package's integrated database and simultaneously displays it on the computer screen using graphics attributes such as flashing or different colors.

Default data capture and display formats give you a clear configuration for simple no-programming operation. The first display is an overview of the system configuration showing the status of all the channels, line by line, in a tabular format. Channel number, value, a text identity comment, and a bar graph representation of the value with alarm limits are shown left to right. You can then view individual channels or groups in more detail using a standard trend display, graphically portraying the movement of measured values over time. You use menus to set these displays up, assigning channel

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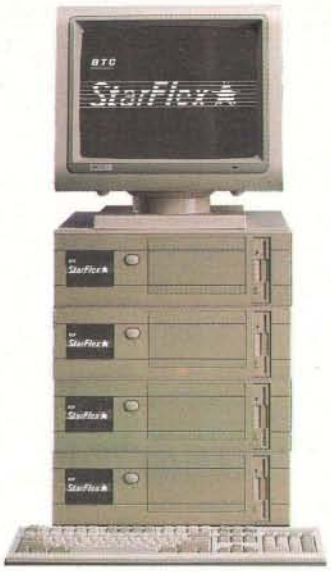

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numbers, comments, alarm limits, data logging frequency, and so on, as required. For more sophisticated displays, you can create custom mimic diagrams using a color graphics drawing package and program generator. Once you have created the desired diagram, you can assign channels to various areas of the display to provide a dynamic picture of the process.

Plant Monitor requires an IBM PC with 640K bytes of RAM and DOS 3.3. You can transfer the database information to packages such as Lotus 1-2-3 for further analysis.

Price: £2500.

Contact: Arcom Control Systems Ltd., Unit 8, Clifton Rd., Cambridge CB1 4WH, UK, 44-223-411200.

Inquiry 956.

Memory Management Products

International Data Security has added QRAM, a software memory manager, to its Memory Management product range. The company has also upgraded its QEMM-50/60 and QEMM-386 products from the same family. All three products include a new utility called Manifest, which provides detailed information on the use of personal computer memory.

Manifest lets you examine and appraise the use of memory by application programs, DOS, devices, and other system components. It gives you detailed information about the configuration of your operating environment, contains reporting and analysis tools, and provides specific suggestions for better use of system memory.

QRAM organizes and allocates memory resources for 8088/8086-based IBM PCs and AT-style 286-based PCs. It lets users of IBM XT and AT computers with EMS 4.0 and enhanced EMS memory load programs into high memory. By loading LAN drivers, TSRs, and mouse drivers into high memory, you can maximize the amount of conventional DOS memory available for large applications. QEMM-50/60 5.0 also lets you load programs into high memory.

QEMM-386 5.0 for 386-based PCs is an expanded memory manager that lets you convert extended memory into expanded memory, thereby letting you break the 640K-byte barrier. With 286-based PCs, QEMM-386 5.0 takes advantage of the hardware capabilities of the IBM PS/2 286 Memory Expansion Option, Expanded Memory Adapter/A, or compatible memory boards, to transform extended memory into expanded memory.

New features of QEMM-386 5.0 that maximize the use of high memory make unused areas of ROM available and optimally choose regions of memory for loading resident programs. The new version also lets you detect potential hardware conflicts with adapters on IBM PS/2 computers and access up to 384K bytes of additional reserved

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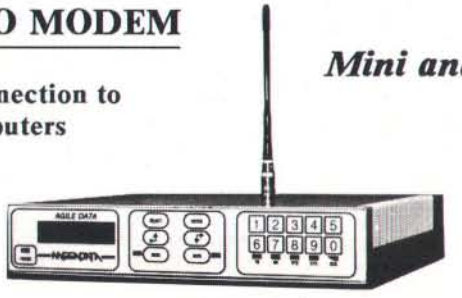

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Contact: International Data Security, 37-41 Gower St., London WC1E 6HH, UK, 44-1-631-0548.
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Enhance Your Hard Disk's Performance

Riva offers Gibson Research's SpinRite II, a software program that can increase the performance of hard disks used in most microcomputer applications.

Enhancements include large hard-disk partition compatibility; a detailed technical log; on-the-fly configuration, which lets you install the program without booting; low-level format defect marking; no disturbance of copy-protected software; and controller track-buffer compatibility.

During operation, SpinRite II creates a detailed record of its findings and actions, which it logs three ways: by their offset (sector and

cluster) within the DOS partition, their byte offset within files, and their physical position (cylinder, head, and sector) on the partition's drive.

When the software detects surface defects, SpinRite II physically records the information in the drive's low-level format. Subsequent high-level reformatting will use this information to avoid all use of that sector.

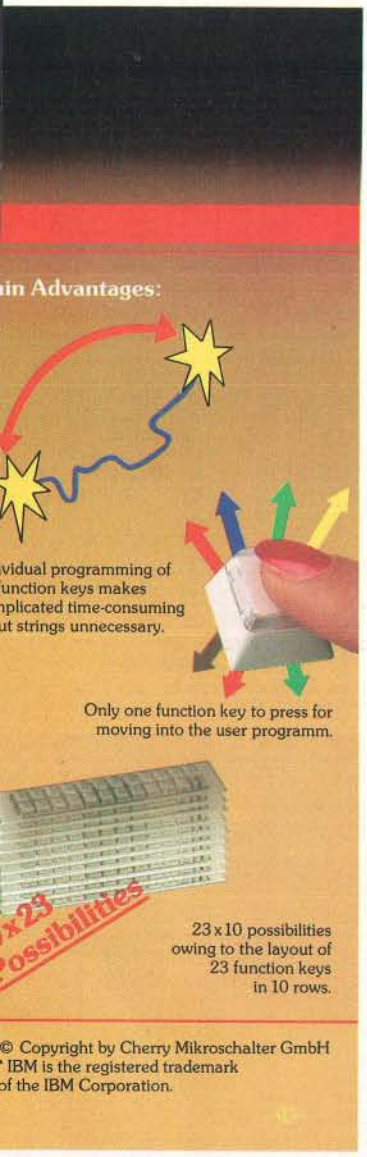
SpinRite II doesn't disturb the hidden unmovable files used by many hard-disk copy-protection schemes. You can use the program without first uninstalling these files.

The new version is fully compatible with DOS 4.0, Compaq DOS 3.31, and large partitioning device drivers. SpinRite II operates with MFM, RLL, ERLL, and ESDI hard disk drives and controllers that employ full-track buffering. You don't need to disable these buffers when using the program.

Price: £89.

Contact: Riva Ltd., 3 Bentley Industrial Centre, Bentley, Farnham GU10 5NJ, UK, 44-420-22666.

Inquiry 928.



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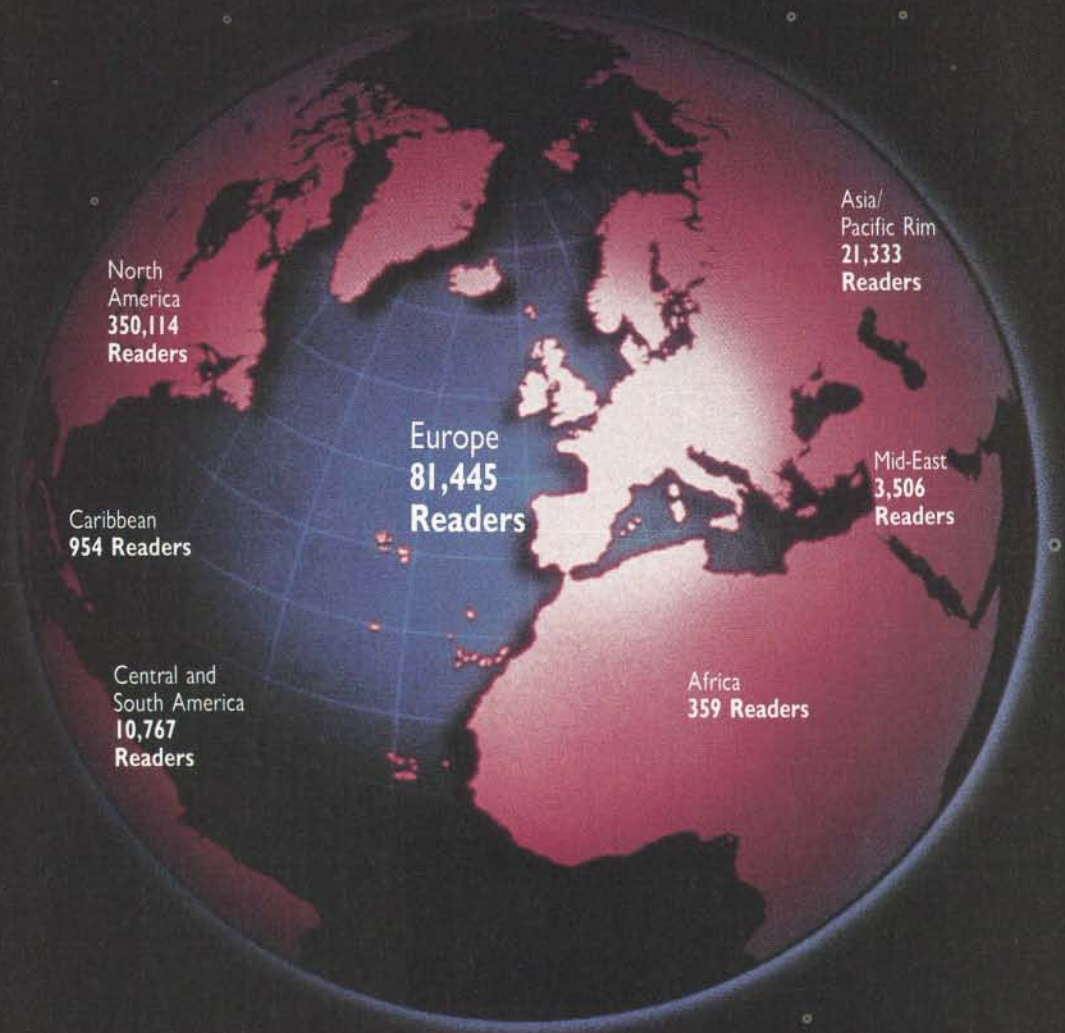

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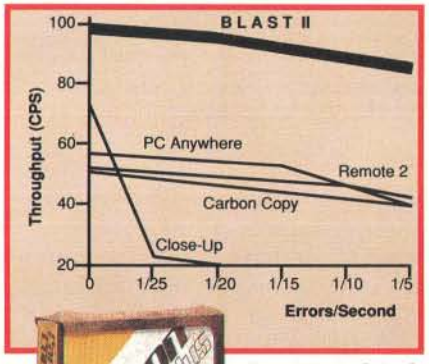

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And since noisy phone lines, static, and defective modems are a fact of life—so are errors! While most remote control programs bog down under poor conditions, BLAST keeps going!

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When it comes to the basics, like file transfer, terminal emulation, unattended operation, and other general purpose communications functions, BLAST does it all! With Lotus-style menus, easy auto-dial and auto-set features, BLAST is simple to use but powerful enough for the toughest UNIX and XENIX communications tasks.

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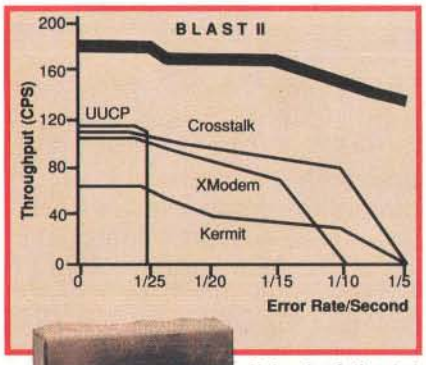

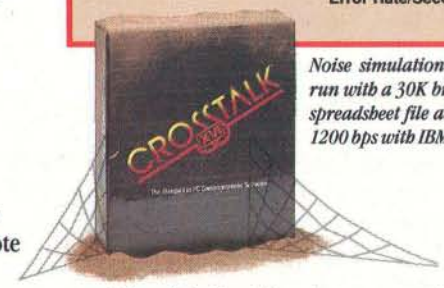

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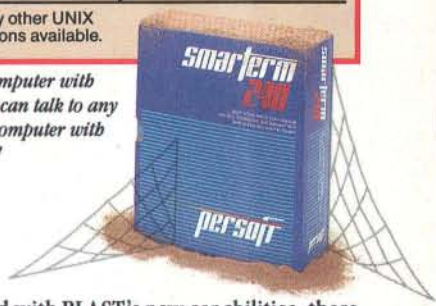

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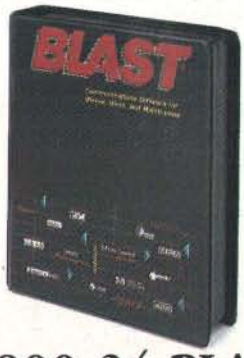

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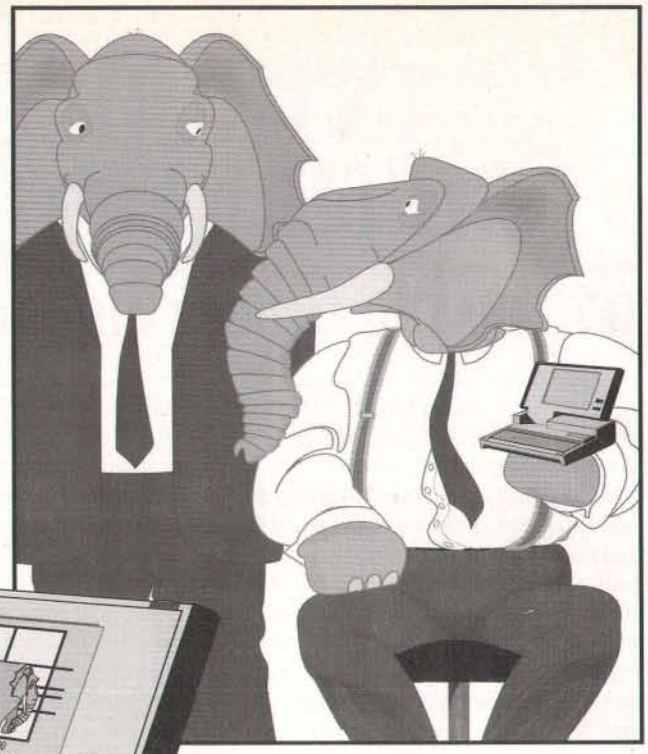

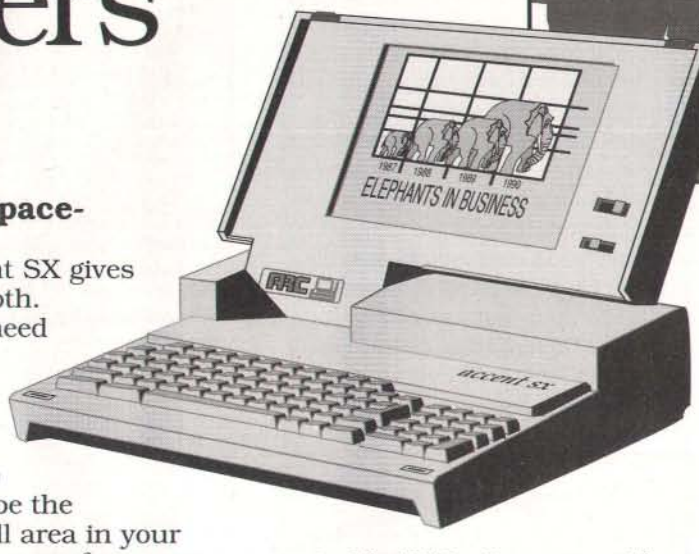

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A TALE OF THREE CONVENTIONS (AND TWO CITIES)

On the road again, Jerry envisions a lightweight dream machine for doctors

They say that if you swallow a live toad first thing in the morning, nothing worse will happen to you or the toad for the rest of the day. This month has been a bit like that: I sure hope nothing worse happens during the rest of the year.

The month began with recovery from the flu, which put me far behind in my work. We then packed up for the annual meeting of the American Association for the Advancement of Science (1333 H St. NW, Washington, DC 20005) in New Orleans. Just before we went, I took my wolf—well, technically he's a husky, but most people who see him think he's a wolf—for a hike in the Hollywood Hills behind the house, where, of course, I contracted a good case of poison oak. Then we flew to New Orleans for the AAAS meeting.

I used to tell the Boy Scouts not to scratch poison oak. It was good advice. I scratched a cut on my ankle, and some tropical bug got in. The result is that I can tell you about the first four days of AAAS, but on the night of the fourth day, I collapsed with a temperature of 104°F and all the classic chills-and-fever symptoms of malaria. Worse, the infection on my ankle wasn't visible under the covers, so I thought I had a flu relapse.

Fortunately Roberta saw it in time to feed me antibiotics and got me to the hospital. The German poet Rainer Maria Rilke died of an infection contracted from the scratch of a rose; in my case, the blood poisoning came from something a lot less romantic, and I'd have been embarrassed to have *that* in my obituary. Anyway, all's well that ends well.

However, I spent the week after the AAAS meeting in bed with Sir Zed, the Sinclair Z88, emerging just in time to get up to San Francisco for the fifth annual CD-ROM conference. We'd scheduled a board meeting of the Lunar Society in San Francisco for the Monday evening before the CD-ROM conference, but we were delayed in driving up.

Meanwhile, Dr. Chapman and Jim Ransom discovered that the Hilton had no record whatever of my reservation, and so gave up waiting for me about half an hour before I got in. Of course the hotel was "full up," and I was hobbling about on a cane, quite unable to go to another hotel and still get to Bill Gates's CD-ROM speech the next morning.

To top it all off, the CD-ROM conference registration people had never heard of me and said, "We're sorry, but we're taking preregistered press only. The conference is closed." My invitation to the conference had come, and I had accepted, by E-mail, and thus I had no paper record. My foot was throbbing, I had missed my board meeting, and the hotel had no room for me. I was literally heading for the Bronco to drive back home to Los Angeles when an official of the conference recognized me and took care of things.

The CD-ROM conference ended on Thursday, which was the day the West Coast Computer Faire began. Both Roberta and I gave presentations at the Faire.

The CD-ROM conference was scheduled for the same weekend as Contact, which after AAAS is my favorite conference of the year; it's a gathering of hard scientists, science fiction writers, and anthropologists, and it does serious thinking about such things as first contact with aliens, and society in the solar system (without aliens) after space travel becomes routine. (For further information on Contact, write to Dr. Reed Riner, Department of Anthropology, Northern Arizona University, Flagstaff, AZ 86001, or look into the contact conference on BIX.)

Contact is held in Phoenix, and before I got blood poisoning, we actually had the mad scheme of attending both Contact and the Faire. Given my condition, we canceled that and stayed in San Francisco for the week. The end of the week was the end of the month; with any luck I won't have a worse month this year....

AAAS

Since it's about a lot more than computers, my full report on the annual meeting of the AAAS will be in *New Destinies*, the "bookazine" published quarterly by Baen Books (Dept. C, 260 Fifth Ave., New York, NY 10001); the essay has the rather pretentious title of "Annual Message on the State of the Sciences." This marks a revival of my old science column "A Step Farther Out," for those who have been around long enough to remember it.

There are formal sessions at AAAS on computers, particularly on the use of supercomputers. There are sessions on computer science, but there's almost nothing on microcomputers. You don't even see the *effects* of the microcomputer as often as I'd have thought. In the past, nearly all talks were given with the aid of crudely drawn transparencies for an overhead projector. Most still are. There are a few slides, with neatly done charts and graphs obviously generated by a microcomputer, but nowhere near as many as I expected.

Moreover, although much of AAAS was devoted to such things as economic considerations in the problem of global warming, and the spreadsheet is an excellent tool for doing that kind of work, I didn't see much of that sort of thing at the meeting.

I'm not sure I understand why this is so. It may be that the AAAS tends to attract the highly successful and well-known, meaning older, scientists, and

continued

that generation simply never got the knack of small computers. In any event, there was no session on microcomputers in science, but there were several sessions devoted to computers and their uses. One of those was on supercomputers: describing some of the work the five National Supercomputing Centers are doing and how supercomputers impact the sciences.

The impact is hefty. Examples of some of the work being done: modeling of biocontrol of agricultural pests, design of air-quality-control strategies, and protein models for drug designs.

My favorite example was Prof. Dean Taylor of the Department of Mechanical and Aerospace Engineering at Cornell University describing the use of supercomputers to model artificial limbs and bones, and the interface of those to living tissue in actual patients. The supercomputers take x-ray images and tomograms and make a three-dimensional model of, say, a patient's hip bone, including a cancerous area; then, in real time, as the surgeons remove the cancerous tissue, the model changes and is used to control milling machines that make up an artificial bone that will fit exactly to the real bone so that the hip joint is restored.

I always come away from AAAS meetings with my batteries recharged for the year.

There were sessions on computer viruses and their prevention; not much on AI, because there isn't much to report just now; computers in geometry, with fractals; mathematical models in the social sciences (there aren't any good ones); and quite a good session on intellectual property rights.

Of course, AAAS is about a lot of things besides computers. Global warming (which may or may not be happening; there's more shouting than science); astronomers reporting on the 1987 supernova, the first in several hundred years and billed as "the chance of a lifetime"; advances in understanding genetic factors in mental illness; bats and killer bees; Frank Tipler on the end of the universe; cosmology, microbiology, and education. You name it, if it's science it's probably there. I always come away from AAAS meetings with my batteries recharged for the year; it's good for me to discover there's still a world out there beyond the computer industry.

CD-ROM

The keynote speech of the CD-ROM conference was interesting: George Gilder, now of the Hoover Institution, telling how microcomputers had started a revolution; that the trend is from giant centralized installations to distributed computing; and one act of the Computer Revolution was to help bring down the Soviet Empire.

I found it interesting because I'd heard it before. So have you, right here in this column, as well as in my other column entitled "The Computer Revolution,"

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which ran in BYTE's lamented sister publication *Popular Computing*. That was before the fact. Now it's all history, which is just as well, but it is amazing how many people now say it was obvious.

It was a good thing I got to the opening session of the CD-ROM conference, because if I hadn't seen it myself, I'm not sure I would have believed it: Bill Gates breathing new life into the 286 chip by announcing that it was the basis of his proposed "minimum-standard" multimedia computer.

Gates is well known for saying that the 286 is "brain-damaged," and for trying to kill it off in favor of the 386 and 386SX for the obvious reason that OS/2 for the 286 is a very clever hack, but no one in his right mind would want to trust his livelihood to it. For a moment there I was reminded of those old movies, in which the mad scientist, accompanied by Igor, digs up Dracula's coffin and removes the stake from the vampire's heart. . . .

Gates's goal remains what it always was: "A computer on every desk, and in every home." The "Base Multimedia PC," which he hopes will become the minimum standard for every home system, is a 286 running at 10 MHz or faster, with at least 2 megabytes of memory; VGA, supporting 8-bit VGA at least; an 8-bit D/A converter; multivoice synthesis with analog mixing; a CD-ROM drive with a seek time of 1 second or better; a 30-MB or larger hard disk drive; floppy disk drives; keyboard, mouse, MIDI, joystick and analog device control support; and DOS or Windows with multimedia extensions.

This, Gates says, can be built today, and over 5 million older PCs can be retrofitted to this standard for under $1000. I don't myself see how; the cheapest CD-ROM drive is $500, and while 30-MB hard disk drives are pretty cheap, they aren't *that* cheap. Still, it's a goal to shoot for; if there were even a million machines like that out in the wide world, there would be a strong incentive to develop multimedia software for them, and it's the killer applications that sell hardware. Look at VisiCalc and the Apple II, and later Excel and the Macintosh.

But there aren't a million such machines; there are only about 360,000 CD-ROM drives installed worldwide. This is double over last year, which was double over the year before, so if the trend continues, there will be 1.5 to 2.1 million CD-ROM drives two years from now. The sound-system part of the Base Multimedia PC is pretty cheap; now if the CD-ROM drive would just come down to $250 or so, things would start moving. Alas, I don't expect that for several years; at the moment, CD-ROM drives fall in price at about 10 percent a year. So it goes.

On the other hand, VGA plus a multivoice sound system will pretty well wipe out any advantage the Mac has over the PC as a multimedia platform. Owl International and others are rapidly developing HyperCard systems for the PC—as well as great improvements over HyperCard. Windows, particularly the widely reported but not yet released Windows 3.0, is at least as easy to use as the Mac OS and has a more solid multitasking base, as does the non-graphical-user-interface (GUI) DESQview (although Apple is moving forward to its own updates). The PC environment is generally easier for programmers to work in than that of the Mac. As a result, we should be seeing some radical new CD-ROM-based multimedia software for PCs within the next year or so.

Having said that, I have to add that the Mac already *has* the GUI and the multivoice sound system, and some splendid CD-ROM products are already available; moreover, Quanta Press (2550 University Ave. W, Suite 245, North St. Paul, MN 55108, (612) 641-0714) is now delivering CD-ROMs that can be read by both Macs and PCs, and Denon and other true SCSI CD-ROM drives can be moved from PC to Mac and back without alteration.

Meanwhile, the war between CD-I and CD-ROM continues. CD-I is "compact disk interactive," and it is based on a Philips design in which the CD drive incorporates a 68000 chip and thus has a number of computing functions built in. CD-ROM is a data storage and distribution system that requires the smarts to be in the computer that uses it.

Philips, in conjunction with Polygram Records, has the theory that CD-I systems can be sold as upgraded CD audio drives: the customer getting a drive to play CD albums will be induced to pay a few dollars more and get the CD-I system "with a real computer built in." This would put vast quantities of CD-I drives in homes across the country, creating a large potential software market and thus powerful incentives for developers to create first-class CD-I software, selling even more drives, and creating a new industry.

By contrast, the Microsoft CD-ROM strategy was to create the market and let it haul itself up by its bootstraps, albeit with considerable help from Microsoft, which developed Microsoft Bookshelf

continued

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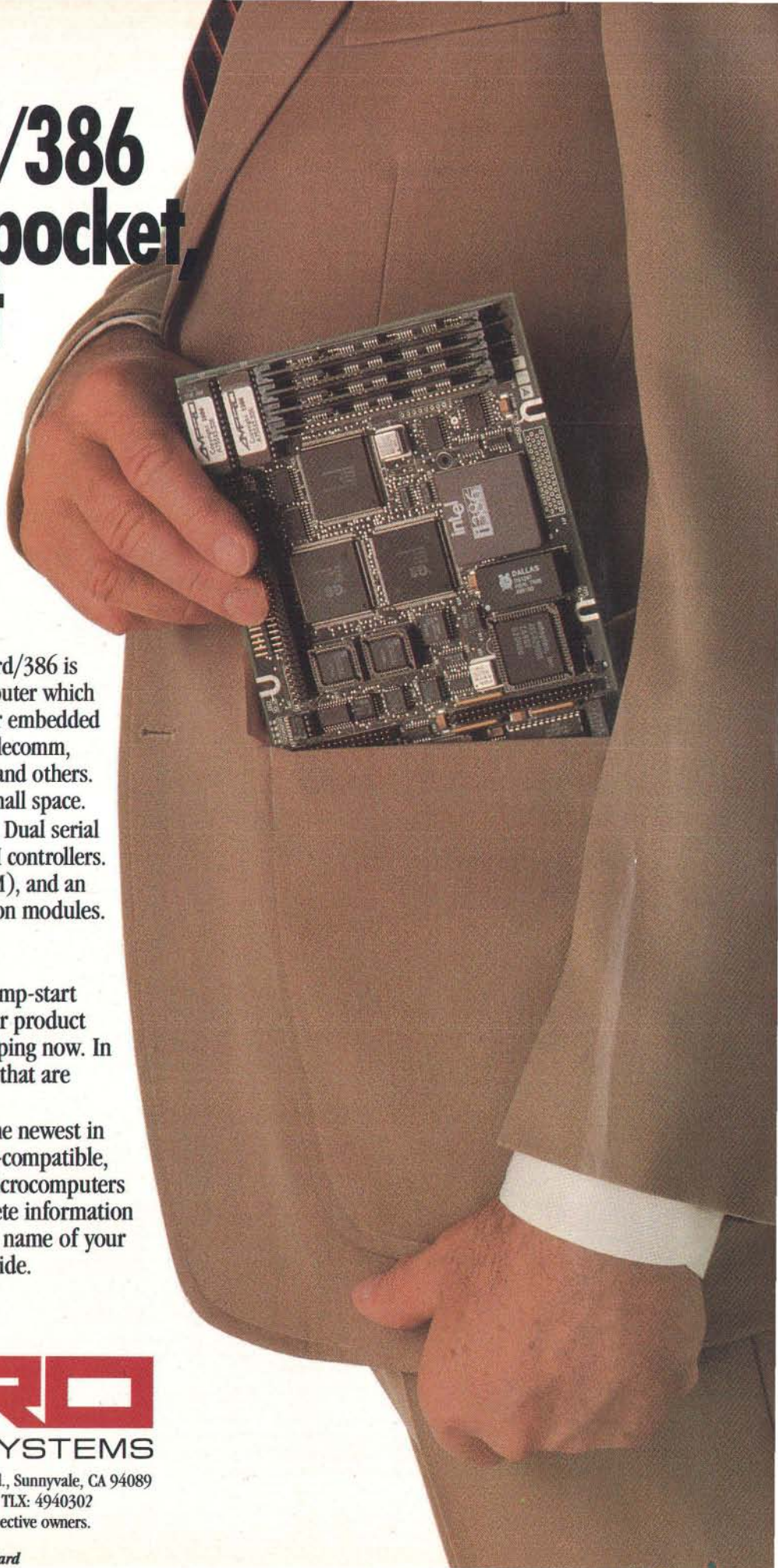

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and Programmer's Library before there was any possible market for them and sponsored the CD-ROM conferences, although there was no demand for them.

The Microsoft strategy is working, as witness the 360,000 drives; after all, four years ago the installed base was zero. Moreover, the Microsoft CD-ROM products are really excellent: Programmer's Library is more than enough excuse for any serious programmer to buy a CD-ROM drive just for the increased productivity, while Microsoft Bookshelf can be very useful to professional writers. There are also Microsoft Office (Word, Excel, PowerPoint, and Mail for the Mac), Microsoft Small Business Consultant, and Microsoft Stat Pack, all extremely useful. The CD-ROM industry owes its existence to Bill Gates, who almost single-handedly created it and continues to support it.

Philips, on the other hand, continues to talk about CD-I and put money into its development, but there's nothing shipping. In my judgment, CD-I has missed its opportunity. If the drives had existed last year, or for that matter if CD-I drives costing no more than double a good audio CD player could be brought to market this year, then CD-I would have a good chance to overtake CD-ROM's installed base of 360,000; but so far as I can see, by the time that CD-I has a practical drive in the audio stores, CD-ROM will be thoroughly entrenched with over a million units out there.

For those interested in working with CD-I, development systems are available from Philips, and the Interactive Support Group (21032 Devonshire St., Suite 209, Chatsworth, CA 91311, (818) 709-7387) sells tool packages for software engineering on Mac, IBM 386, and Sun workstations.

CD-ROM isn't just a means for storing information. It's also a means for accessing it; and that, really, is the important part. Whether the smarts are in the CD-ROM drive or in the computer isn't half as important as that the smarts are there in the first place.

CD-ROM News

When I began writing this column, I attempted to cover every major development in the microcomputer field. I couldn't do it, of course, but in the days before CP/M became the "standard," I could try. Now if anyone seriously claimed to be covering the entire microcomputer field, the men in white coats would come to take him or her away.

It's much the same with CD-ROM developments now. Four years ago I could cover the whole field in part of one column each year. There weren't many CD-ROMs, and most of those were highly expensive specialized databases like MicroMedex (still an excellent medical reference system). Now if I were to devote most of each column to CD-ROM, I couldn't cover the field.

Every month, the Bureau of Electronic Publishing (141 New Rd., Parsippany, NJ 07054, (201) 808-2700) brings out a dozen new CD-ROM products. Hardly a week goes by that I don't receive some outrageous promotion gimmick—today it was a 7.62-mm ammunition box containing a camouflage headband and a CD-ROM called Vietnam Remembered from Wayzata Technology. More companies are entering the drive market with true SCSI drives that work with both Mac and PC systems (and, since it's true SCSI, you can daisy chain other stuff onto your PC without using another slot).

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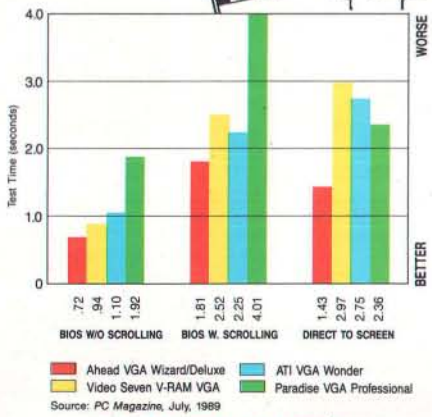

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The price of drives will continue to come down, but even at today's prices, CD-ROM is worth having. By the time you read this, you should be able to get *Compton's Multimedia Encyclopedia* on CD-ROM (hear portions of Kennedy's inaugural, see his picture, and read the text); U.S. history on CD-ROM, including hundreds of documents and commentaries; specialized databases, like all that's known about acid rain; software; games; and, as they say, much more.

There's another way that CD-ROM is changing the world; at the conference, Digipress (2516 River Bend Dr., Louisville, KY 40206) announced their Century Glass Master and Century Disc. Their new process for CD-ROM production replaces the traditional master, father, and mother disks with the Century Glass Master; this reduces manufacturing time. More important, though, disks made with their media will last a hundred years.

Meanwhile, 3M announced same-day turnaround: get the electronic data to 3M in the morning, and you can have a CD-ROM that afternoon, guaranteed. For all practical purposes, any data scanned or keyed into electronic format can be made eternal. I'd expect that within a decade the process of putting the entire Library of Congress on CD-ROM will be nearly complete.

The bottleneck in CD-ROM continues to be data entry. Scanners are slow and unreliable. Optical-character-recognition (OCR) technology is still in its infancy: there's no problem scanning in typescript, or text that is well printed on high-quality paper. But for older books on cheap paper, where there are ink runs and malformed letters, scanning is almost impossible.

Neal Schulman's new Softserv Publishing (10944 Strathmore Dr., Suite 21, Los Angeles, CA 90024, (213) 824-5145) is publishing books in electronic format. It's a new concept: you pay (with a credit card) to download a book. Example: Harlan Ellison's short story collection *The Beast That Shouted Love at the Heart of the World*. There will be a number of others. This means they're very interested in the latest in scanners and other methods of getting text into electronically readable form. Alex Pournelle is working with them to install the latest and best equipment and OCR software. Schulman has unique assets, including fans who will do some of the scanning work as a labor of love.

A CD-ROM, however, can devour enormous amounts of text, so it's no wonder that this has generated firms whose major business is getting data from printed to electronic format. One of these is Data Development (49 West Flagler, Stuart, FL 34995, (407) 288-2773), which not only does scanning, but has arrangements to key in data that isn't really scannable. The Data Development people tell me that when the scan error rate gets to about 5 percent, it's cheaper to send the stuff overseas to be keyed in. I can well believe that, having experimented with scanning badly printed books myself.

Probably the most dramatic exhibit at the CD-ROM conference was Fujitsu's FM Towns System, a 32-bit graphics workstation with built-in stereo sound and speakers, editor, home entertainment center, CD-ROM reader, color scanner, SCSI controller, Japanese-language ROM, and enough other stuff to fill a paragraph. As I understand it, there are no present plans to market this in the

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U.S.; but as a demonstration of what home computers can be like, this thing was magnificent. (For information, contact FM Towns Support Center, Sutter Place, 1375 Sutter St., Suite 400, San Francisco, CA 94105, (415) 928-7270.)

The theme of the CD-ROM conference this year was multimedia presentations. As you'd expect, there's more potential than shipping products there; but that's changing, too. A dozen or more firms offer tools for authoring multimedia products. Organizations like Activision with their older CD-ROM, The Manhole, and the newest one, Cosmic Osmo, demonstrate some of the potential in products you can get now.

I Have a Dream

I see that I'm trying to cover the whole CD-ROM show, and that's not possible. Instead, let me paint you a vision.

The badges for the CD-ROM conference were 3-inch CD-ROM disks. These are nothing more than cut-down CD-ROMs; they hold about 300 MB. The drives are correspondingly smaller and can be made thinner.

Consider a Sinclair Z88 computer: for those who haven't seen one, it's about 12 by 1 by 8 inches and has a full standard keyboard and an LCD screen. Software, including a spreadsheet, a word processor, and a very powerful BASIC compiler, is in ROM. There are slots for three cards that can hold more memory or more software, and there's a data port. The whole machine is covered by a black rubberized skin and thus is waterproof. I've carried Sir Zed for over a year now, and I'd be lost without him.

Now imagine that machine with a 3-inch CD-ROM drive installed. On that CD-ROM you could have, say, the *Physicians' Desk Reference*, with complete indexing and access software. Imagine a physician carrying that machine while making hospital rounds. While a patient is being seen, appropriate records are called up. The physician can update the nurse's chart (or plug the data port into the wall to allow the hospital central computer system to do it, but I have in mind a totally self-contained system) and can add observations and conclusions in consultation with the Physicians' Desk Reference CD-ROM.

Back in the office, the physician sets the machine in a cradle, recharging its batteries—and simultaneously squirts observations and data into the hospital central system, where an expert-system program examines what has been done. Seconds later the screen flashes. "YOU HAVE INDICATED TREATMENT THAT MAY BE NONSTANDARD FOR THIS PATIENT'S CONDITION. PLEASE RECONSIDER AND CONFIRM." Or, more likely, the expert system sees that what is being done is well within established practice and says nothing, but it integrates the data into its memory banks as yet another confirming instance.

Now imagine the liability insurance premiums of that hospital a couple of years later.

One reason to go to conferences is to meet people you didn't know you needed to meet. At the CD-ROM conference, by chance, we had lunch with Richard K. Wertz, M.D., president of Digital Diagnostics (601 University Ave., Suite 255, Sacramento, CA 95825, (916) 921-6629), a company interested in CD-ROM medical databases and publications. I put my "dream" to him. He liked it, but he pointed out that physicians have been resisting using computers for fear the machines will make their work irrelevant. Longtime readers of this column will recall I ran into the same sentiments when I talked to medical students in CP/M days.

"Pilots aren't afraid of checklists," I pointed out.

Anyway, it's a dream; but one I think will happen well before the end of this century.

West Coast Computer Faire

There were about twice as many people at the Faire this year as last, so it's legitimate to talk about a comeback. Not much of a comeback, perhaps, but a comeback. Moreover, the Faire still has about the best conferences of any show I know.

What's missing is the exhibitors. I have a couple of observations about that. First, the big boys have stopped coming, and some of them ought to be ashamed of themselves. Microsoft, for instance. This show built Microsoft. Broderbund: you could trace Broderbund's progress from a tiny booth selling games for the TRS-80, to a larger booth selling general-purpose games, to a major player with a big booth up at the front of the hall.

Apple: I recall when the first thing you saw walking into Brooks Hall was a giant Mac. Now Apple thinks it is too successful to come to the Faire.

The magazines used to be at the Faire. Many of them, including BYTE.

Well, all things change; why should these companies care? What's in this show for them, other than nostalgia?

Plenty, I'd say. This is where their customers are. Now, sure, for a big company the customers are dealers, not end

continued

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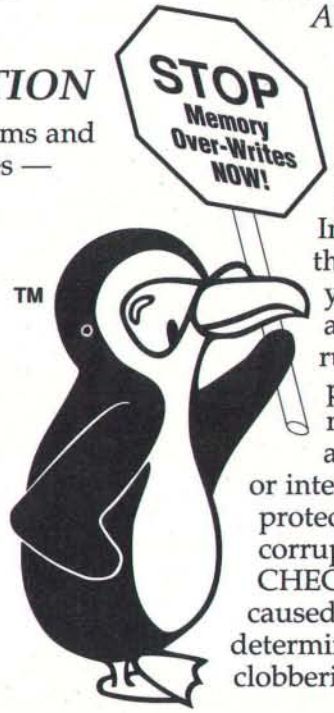

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users, but for that very reason the feedback is filtered through dealers, and I'd say it is important once in a while to talk directly to the users. In particular, it's important for the development staff, the wizards who hate Comdex, to come to the Faire, where they get to talk not only to customers, but to each other, and get some cross-fertilization. Some of that happens at the Hackers' Conference, of course, but Hackers' is invitational and a bit intense. The Faire is a good compromise, with wizards, dealers, and users all present.

Then there's the Holy Grail of Home Computers. At the CD-ROM conference, Bill Gates said that the goal is still a computer on every desk and in every home. He meant it, too; but when do his people get to talk to those who will be using the home computer? You can do only so much with focus groups and market research—and that stuff costs as much as coming to the Faire anyway.

We're not asking for the big parties like we had in the old days. Do that at Comdex. But I do think it can't hurt to let the people who are designing OS/2 and Windows and DESQview and Apple's new operating system, and multimedia and education software, and all the other stuff, to come to the oldest computer show of the lot and talk to end users.

I fault the Interface Group, the Faire organizers, on one point. Up at the Hilton, half a mile away and one day before the Faire, there were a bunch of start-up companies looking to establish themselves in the CD-ROM field—including in the home market arena. Why weren't they at the Faire? I'd bet they could have sold enough CD-ROM drives and disks to cover most of their cost, and they would have increased their name recognition.

One last point. The West Coast Computer Faire comes during the silly season, between Fall and Spring Comdex, a time when most of the computer press is looking for stories. It used to be that the Faire was a place to announce new developments. That's died away; but the press is at the Faire (and it's not hard to get more to come if there's a reason) and looking for stories.

Tutsim

My Faire speech was Saturday afternoon. I'd crashed Friday afternoon—I hadn't completely recovered from the infection—so Saturday morning I found myself in my hotel room without the foggiest notion of what I should say. Usually that's not a big problem; I scratch out some notes to remind me of major points and speak extemporaneously. This time I wasn't so sure I could do that, what with residual effects of the high fever I'd had.

Anyway, Saturday morning I sat down at the Zenith SupersPort and fired up GrandView with a view to making some notes, and by golly, within half an hour I had a pretty good speech worked out. There was only one problem. I had no way to print it. Surely, I thought, someone at the Faire will have a printer I can connect up. If not, well, if worse came to worse, I could use the computer itself; it is, after all, a laptop.

I didn't have to do that. One of the first people I ran into at the Faire was Walt Reynolds. I first met Walt back in CP/M days, when his company was called Applied I. Now it's Tutsim Products. He had a printer that served nicely.

I've mentioned Tutsim before: it's a simulation program that in effect turns your PC into a series of analog computer operational amplifiers. I don't know just how many BYTE readers will remember the days of op-amp computers, which did multiplication, integration, differentiation, and suchlike; you connected these amplifiers together with precision resistor networks, fed back some of the output to the input for integration, and so forth.

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*Written by Neil Martin of the British Standards Institution (BSI) and printed in Personal Computer World June 1989, page 241.

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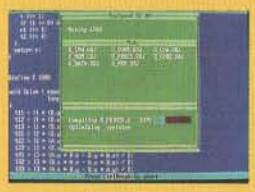

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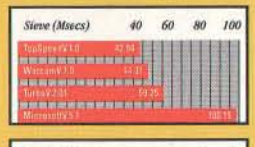

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Benchmarks measured by Mark Hamilton, November 24, 1989.
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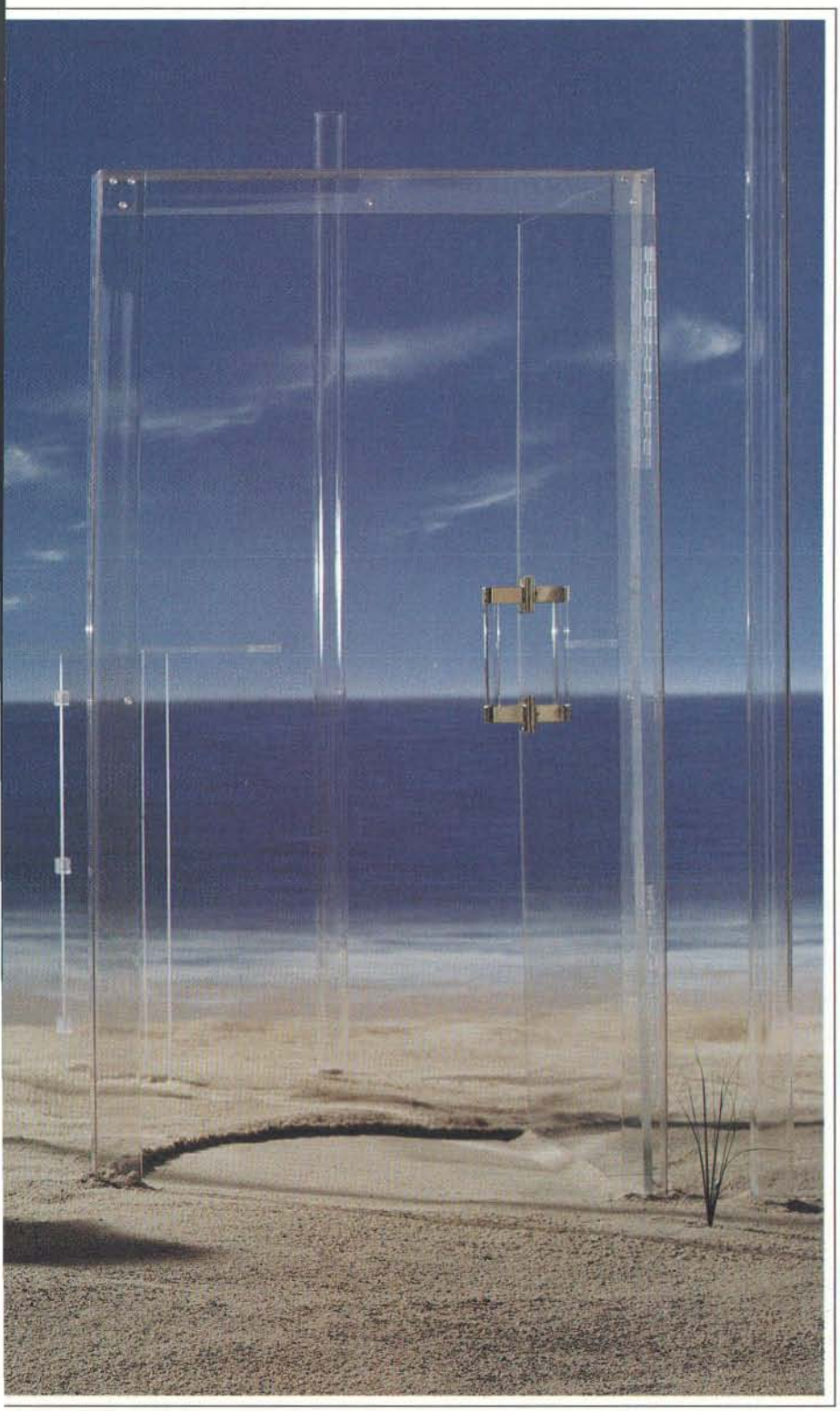

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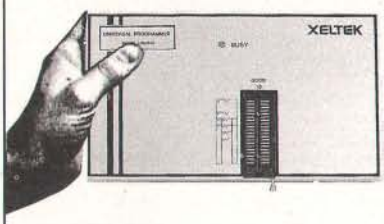

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just draw the op amps and their connections, and your PC does the rest.

Back in 1982, I told Walt that I thought his program was really neat—it lets you do on a PC a lot of the simulations that programs like Extend do on the Mac—but the price was too high. This year he agreed with me: the price for individual users is now under $100 (and there are special deals for students).

Tutsim is fun, but it's also a sound professional tool useful for anyone in engineering. I've played about with it for a number of things; the latest was to build a delayed feedback model of the U.S. economy. That's a notion I got from an agreeably thin and surprisingly readable book, *Feedback: A New Framework for Macroeconomics Policy* by D. A. Kendrick (Advanced Studies in Theoretical Econometrics, Kluwer Academic Publishers, 101 Philip Dr., Norwell, MA 02061). Tutsim works fine for that.

You can think of FracTools as a professional's fractal investigations toolbox.

Tutsim can be used with MathCAD. You use MathCAD to write the report and build up the problems and then use Tutsim to solve the ones that require dynamic feedback or difficult integration. Tutsim gives both numerical and graphical answers, and while you need to know something about how to model what you're simulating, beyond that it's not particularly difficult to learn and use.

Old Friends

Fred Cisin of XenoSoft has been a permanent fixture at the Faire since it began. XenoCopy-PC isn't a spectacular program for the PC and compatibles; what it does is read a whole bunch of disk file formats, from Apple to Wang, and if there's any way to transfer files from a strange disk to your PC, XenoCopy-PC can probably manage it. If you've got file transfer problems, you can't really do better than talk to Fred about them; if he doesn't know who can solve your problem, it's likely no one can.

Another familiar group was Bourbaki, an outfit that likes to subtitle itself "Revolutionary Software," whatever that means. Bourbaki makes two products, 1Dir+ (pronounced "wonder plus"), a DOS utility shell that competes with Norton Commander (and which many prefer to the Commander), and FracTools, which is a kit of programs and images for playing about with fractals.

Fractal is a term coined by Benoit Mandelbrot to describe objects that are similar to themselves at any magnification. For example, the seashore: from a great height it is irregular, and as you get closer it still is, right down to the level of grains of sand and below. Clouds and trees have fractal properties.

There are also mathematical techniques for generating fractal images. One of these is FracTools. FracTools will draw pretty pictures, generate fractals, help in designing stained-glass windows, and suchlike. The program is designed to work with 1Dir+, but it does not need to. You can think of it as a professional's fractal investigations toolbox.

If all you want is to play about with the Mandelbrot set (one group of fractals discovered by Mandelbrot), the simplest way is to get hold of Mandelbrot 3 from Midnight Beach, whose subtitle is "Software for its own sake." At $25 this is the fastest and cheapest way to find out if you like playing with fractals; indeed, Mandelbrot 3 is startlingly fast compared to most such programs.

The program started out as Jon Shemitz's hack for his own amusement and only later became commercially available. Last year I mentioned the company as Emerald City Software. This year the company has changed its name. Mandelbrot 3 is fast, easy to install and use, and cheap. Upgrades are nominal to free.

I found one bug in the program. If you put it on a fast 386 that has a mouse driver but no mouse and attempt to direct the cursor with the arrow keys, two things occur: the image isn't centered properly on the screen to begin with, and as soon as you touch an arrow key, you'll lock the system completely. The remedy is simple enough: install the mouse or dump the mouse driver. In my case, I turned the machine off (it was really locked up), attached the mouse, turned the machine back on, and voilà!, it worked perfectly. I should have had the mouse attached in the first place; while you *can* run Mandelbrot 3 with the arrow keys, I don't recommend it. Use a mouse. It works a lot better.

Mandelbrot 3 requires either an EGA or VGA board and is absolutely gorgeous when used with a Tecmar VGA board

continued

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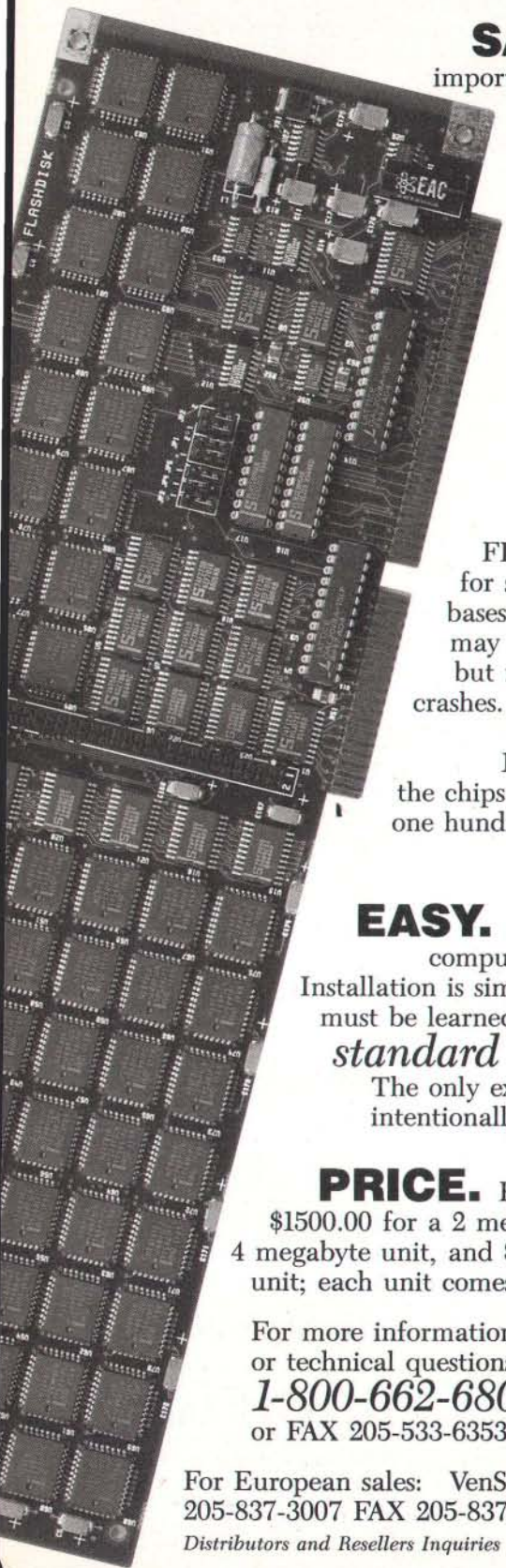

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DIGIPRO

and the 19-inch Electrohome monitor. Recommended.

Midnight Rescue

While I was writing this, Roberta was playing with a new package from The Learning Company, Midnight Rescue. This is an arcade-type game that involves trying to rescue the school from an evil madman who looks like a cross between Albert Einstein and Dr. Demento and acts accordingly. Some of the arcade sequences don't seem to work the way you'd expect, and every now and then the program cries "Gotcha!" The error loops say "Wrong, try again," which is unhelpful; as Roberta says, most kids hate it when the program says that.

Her conclusion is that it's a decent program and might be a fun game for a while. It isn't likely to be the educational marvel that it claims to be. If kids will play this, they'll learn a few things and may have fun at it. It won't change their lives, but then I can't think of many computer games that will.

Winding Down

While I was on the road, more *stuff* accumulated here. I'll try to sort some of it out, but I wonder when.

The book of the month is *The Price of Admiralty* by John Keegan (1989, Penguin USA); this is a thoughtful history of naval strategy and what makes naval power. The game of the month is Harpoon, the computerized version of Larry Bond's modern naval warfare board game that provided the major data source for Tom Clancy's seapower novels. The first version had a number of near fatal bugs, but the upgraded version is pretty stable, and the publisher is very good about revisions. Harpoon models U.S. versus USSR actions.

Just after I got the game, I received an invitation to visit the Soviet Union. I figure I better go while it's still a Communist country; soon those may be on the endangered species list. If I don't get back, send over more microcomputers. ■

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. Jerry welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply. You can also contact him on BIX as "jerryp."

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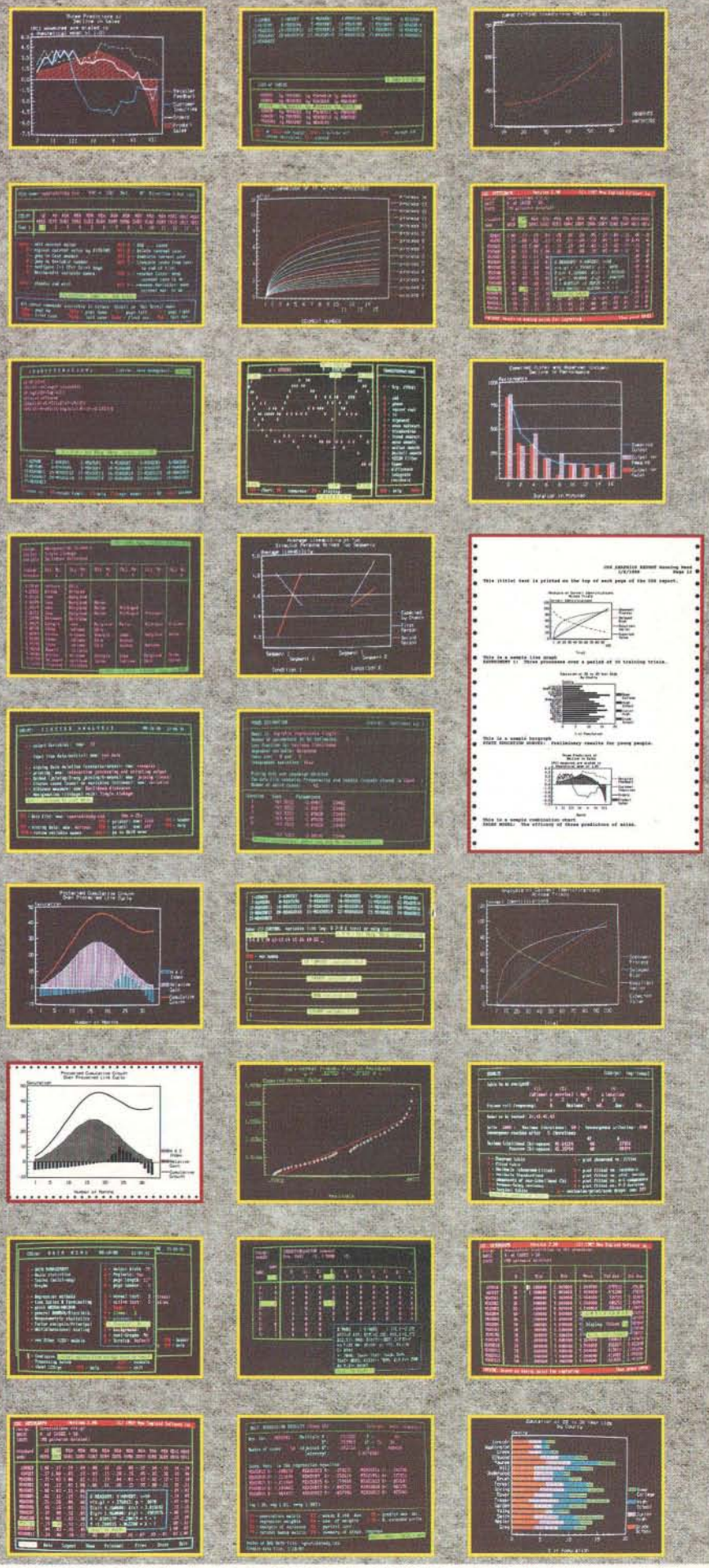

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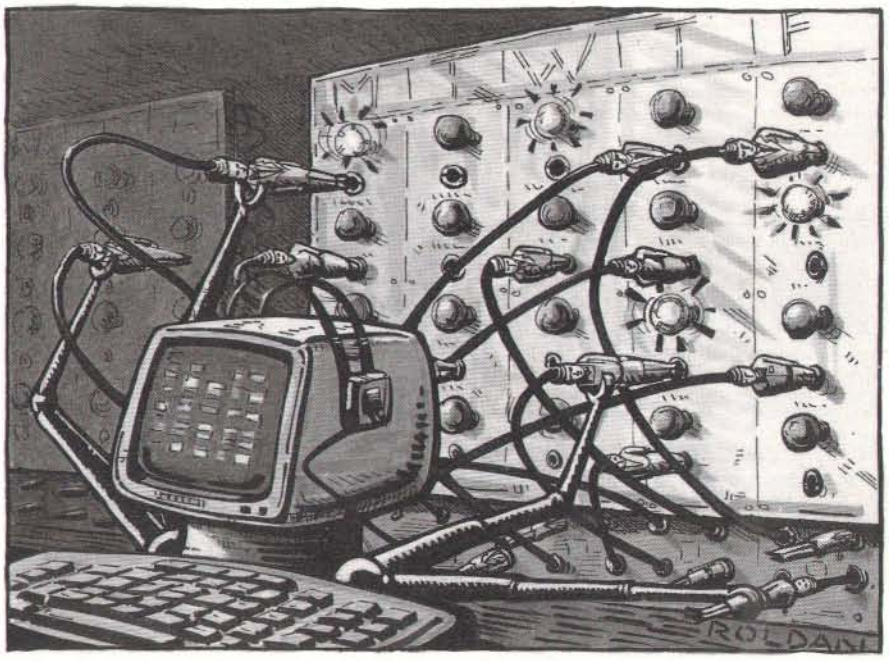
WHO, WHAT, WHEN, AND WHY NOT?

Using an employee scheduling package can teach you many things about your business



It's 6:30 Thursday evening, and you are busy trying to get the employee work schedule ready so that you can post it tomorrow. You run two shifts in a suburban convenience store, and you have to make sure that the right people are on duty. You look at your list of employees and start to work, knowing that it will take you hours and wishing there were an easier way.

The problem with employee scheduling is that you can't just fill a gap in a given day with a warm body. You have to make sure that you have the right mix of skills and seniority, you have to account for people's days off and personal preferences, and you have to account for such things as vacations. Finally, you have to be sure that you're adequately staffed during busy periods but not overstaffed during slow times.

A closer look at the employee records makes you realize that a headache is in the offing. Your head cashier is heading off for his long-awaited vacation in the Cotswolds on Thursday. He's one of the people who's capable of running things by himself, who's bonded, and who's authorized by the state to sell beer and wine. You have to have an approved person in the store at all times to sell alcoholic beverages. Oh, and Zelda Gonzo has just been called to serve on a federal grand jury that will be investigating the mayor, an activity that will probably take months.

To make matters worse, you have several employees who have strong preferences against the second shift, either for family reasons or because the buses stop running at night. Then, you have some high school students who are working part-time in the afternoons. Balancing the needs of the employees, the needs of the business, and the requirements of external events makes you hate having to figure out each week's schedule.

Software to Ease the Troubled Mind

Employee scheduling is difficult because it is an iterative process that involves trying to fit many variables together as well as possible. Two of the tasks at which computers excel are handling iterative processes and dealing with many variables. Given the right software, a computer should be a great aid to efficient scheduling. So why aren't computers used for such applications more often? The reason may be that good software isn't widely available. Another reason may be that even good software requires a fair amount of manual work and advance planning.

Fortunately, there is some good software around. While researching this column, I looked at two packages: Who Works When 1.1 from Newport Systems and Schedule Master 2.01 from Schedule Master Corp. While they are quite different, both attempt to take the drudgery out of employee scheduling. To some extent, they succeed.

One of the challenges of scheduling is treating employees as people. They have quirks, sudden changes in requirements, and personal preferences about things like work hours, and they want their employer to accommodate them whenever possible. This means that if you plan to keep your employees, you can't simply assign them a schedule without regard to their individual needs. You also have to consider external requirements, such as labor laws, qualification requirements, and even the availability of local transportation.

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If you are going to make any software package support your business scheduling, you first must determine your applicable requirements. You have to write down what each employee needs, what the business needs, and what the law requires. If you're using a computer, you must have a way for the computer to consider all this information. Thus, you or someone who works for you has to type this information into the computer.

Once you have all your employee information in one place, you can learn new things about your business.

In addition, the software package has to be able to support the vagaries of the employees and other requirements. If an employee tells you that he or she needs to be off on alternate Tuesdays for a visit to a sick uncle, you need to be able to handle that. You also must make sure that your employees can go on vacation, and that the package can handle other foreseeable business interruptions, such as holidays.

Likewise, you need to be able to define skill categories and shift preferences. If the state requires you to have at least one qualified person on the premises to sell alcoholic beverages, or if you need to have a bonded employee available to make deposits of cash receipts, you must have a way to flag these employees, as well as to tell the software that these obligations must be met.

Most businesses have special requirements such as these. An insurance company may need to have a casualty underwriter on hand at all times, for example, or a hospital may need to keep an emergency room nurse on call. A package that will schedule your employees must be able to handle all these factors.

Helping You Plan

Although Who Works When and Schedule Master will do a lot to help you figure out when your employees will be working, there's still manual work to do. Your employees have to determine their preferences, and you have to determine the requirements for your business and for meeting its external obligations. In addition, you have to define shifts, classes of employees, standard work hours, vacation and holiday periods, and overtime requirements.

Once you have collected or developed this information, it must be entered into the software's data storage so that it can be used to prepare the scheduling. Be sure you have developed a consistent method of collecting the information you need, because this data needs to match the information that the software expects as closely as possible.

Both packages help you with this job. Schedule Master includes a large supply of employee entry sheets. Each form has a place for the employee's personal and preference information, as well as a place to enter business-related data such as skill level, classification and status, and wages. Who Works When includes samples of similar sheets that can be photocopied for the same purpose, but they seem intended for management to fill out rather than the employees.

Despite the work it will save you, no scheduling package will help you much if it's not flexible enough to handle real-world requirements. Both packages let you change work assignments after they have been scheduled in order to meet employee needs that aren't definable by standard rules. You might, for example, define a minimum shift duration as 6 hours, and then manually change the schedule to give employees some extra time off for personal needs or to reward them for extra effort.

Reports

As you can imagine, all this employee and work information can be a gold mine. Once you have all your employee information in one place, you can learn new things about your business. You can, for example, decide if a particular time period is profitable, because you will be able to determine the receipts for that period and compare that figure against the cost of sales for the same period. Since you now will know your staff costs, finding out the other parts of the equation is fairly easy.

Of course, the primary goal of these packages is to produce a work schedule. Both packages do this, although each approaches the job differently. Who Works When prints out the weekly schedule for each employee and lists the work times for each day. Schedule Master prints out a daily schedule or a weekly schedule

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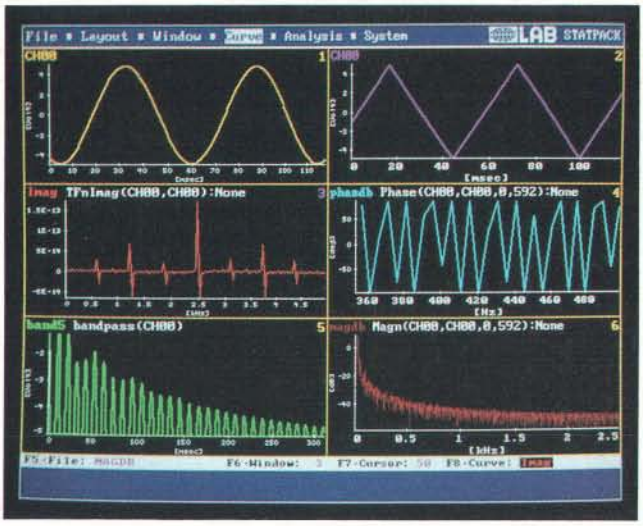

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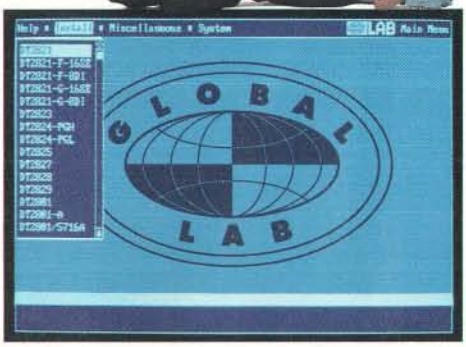

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Who Works When 1.1 .....$479
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and indicates employee work times with bars that resemble those on a Gantt chart. The actual beginning and ending times are printed along with the time lines, giving you a complete view of the schedule at a glance. Who Works When provides the actual hours scheduled and also indicates when you are understaffed and by how much.

Despite the fact that these packages do nearly the same thing, they seem to be aimed at different types of business. Schedule Master, for example, seems to be oriented to the grocery and retail world, while Who Works When is aimed more at hotels and hospitals. You can probably use either package with just about any kind of business, although Who Works When will handle scheduling for a larger organization than Schedule Master, which has a limit of 300 employees.

Either package will work with most small and medium-size businesses, even those with complex scheduling requirements. You will still have to do some manual work, but the whole process can help you manage your business because it will force you to look at your staffing more carefully. It may even make your employees happier, simply because their time will be scheduled consistently and more efficiently. ■

Wayne Rash Jr. is a contributing editor for BYTE and a member of the professional staff of American Management Systems, Inc. (Arlington, VA). He consults with the federal government on microcomputers and communications. You can contact him on BIX as "waynerash," or in the to.wayne conference.

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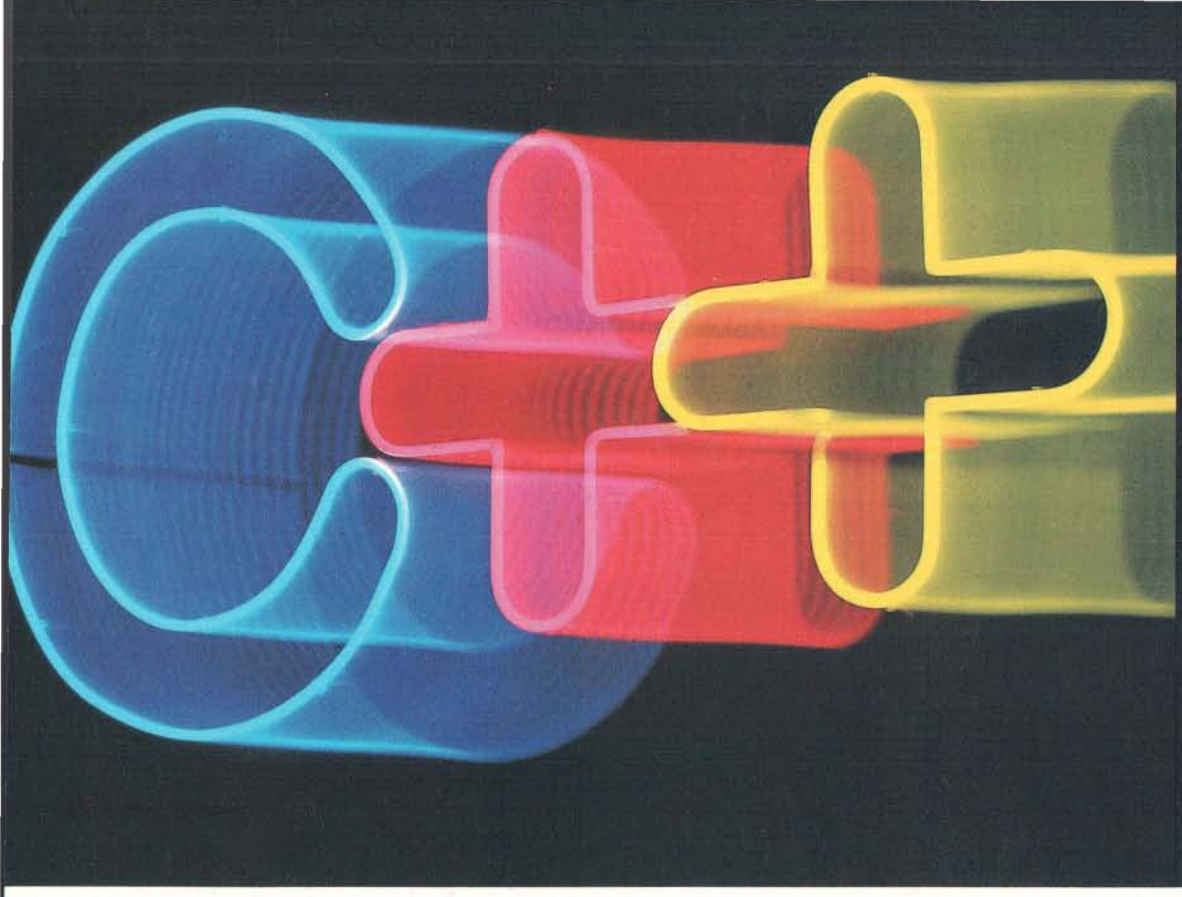

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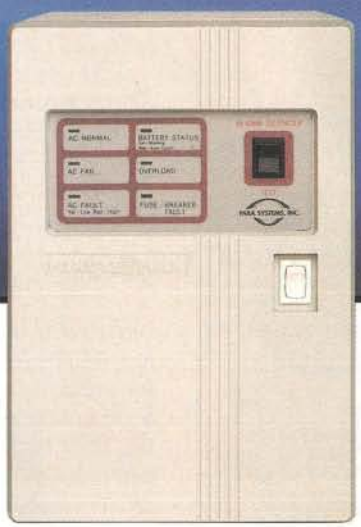

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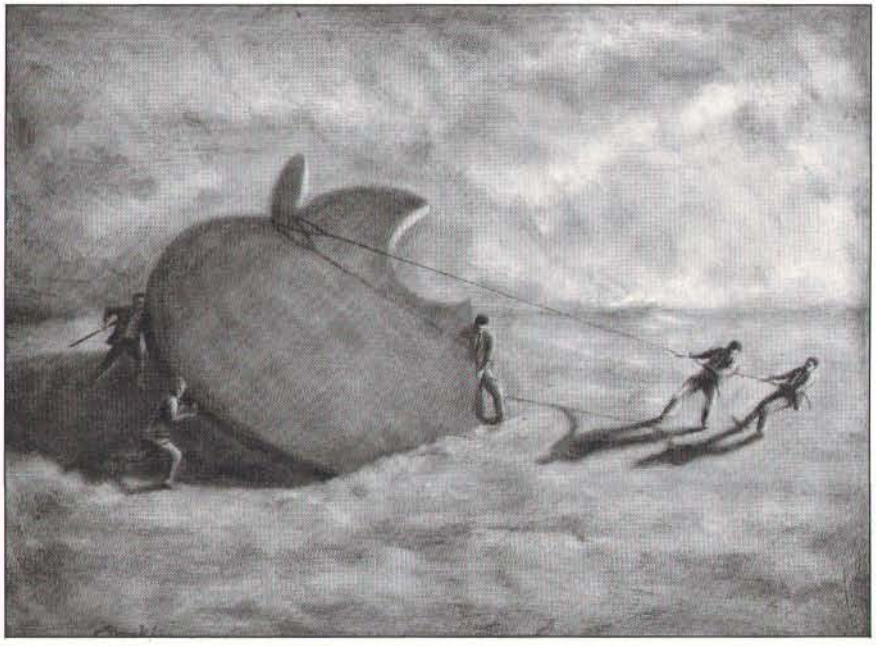
RISING FROM THE ASHES

Apple can regain its prominence if it tackles problems with both the low and high ends of its product line



So far it's been a tough year for Apple Computer. Yet another reorganization, this time in the company's upper echelons, ushered in calendar year 1990. Nor were the lower levels spared: Layoffs sent many longtime Apple workers to the unemployment line. A lot of analysts, columnists, pundits, and just plain folk have suggested that 1990 is the watershed year for Apple. Well, it's not my style to "suggest" anything. I pretty much bull ahead where other people fear to tread, so let me make my predictions about Apple for this year and next.

Crystal Ball Time

Prediction number 1: This year is the most important year for Apple since the debacle known as 1985. If Apple can't get costs under control and build cheaper computers that fit the real business market out there (not the imaginary Department of Defense budget-style industry dreamed up by the marketing department), it will fail.

Apple must spend its money where it will do the most good: real customer service (beefed-up training and implementation assistance in each Apple operational region) and real customer support (toll-free telephone hotlines as a starter). These are services that other computer companies managed to offer without going broke years ago. Apple has to follow suit.

Prediction number 2: Apple will announce the Macintosh Classic (often called the CheapMac). With its two biggest top-brass detractors (Allan Loren and Jean-Louis Gassée) now gone, now-reigning chief operations officer Michael Spindler will ram it through the Fremont factory before the year is up.

It will list for less than $1000 and cost much less than that to make, allowing Apple to still make a good buck. It will use a 16-MHz 68000 CPU (Apple hasn't stockpiled 5 million of these suckers for nothing), and it will come with at least 2 megabytes of RAM (so that System 7.0 will run), a built-in 20-MB hard disk drive, and a 1.44-MB FDHD drive. The design will emphasize modular construction and the current 9-inch, 512- by 348-pixel monochrome monitor that the Mac Plus, SE, and SE/30 use.

Prediction number 3: Apple will lower its price line across the board to fit everything in under its most expensive machine, the IIfx, which was announced in March. The company has to compete better with Unix workstation vendors, who have taken the high ground from them. The IIfx is a nice machine—unless it has to compete pricewise with SPARCStations, IBM RISC System/6000s, and NeXT Computers. Then it comes up way too short for the money.

Prediction number 4: Apple will rise from the ashes of slowing sales in 1989 and 1990 and the draconian measures needed to make it profitable again. Next year will be one of rising Apple expectations and profit margins, as Spindler gets control of things and brings some common sense to the company.

Expect to see more Apple CPUs in 1991 that further broaden the product line, improve the Mac's price/performance ratio, and help remove Apple's worst problem, the "not invented here" syndrome. Among these new CPUs will be several new Macintosh Portables, including models that are actually portable and affordable.

continued

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MasterJuggler 1.5 ..... $89.95
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Prediction number 5: Apple will release 68040- and RISC-based Macs in 1991. While Apple won't be able to keep pace with Sun's latest SPARC implementations or even IBM's RISC monsters, it will make an effort to remain competitive, especially by off-loading work that burdened the CPU onto application-specific ICs and custom processing chips. Also, Apple will ship its first computer designed as a multiuser system from the ground up, something I call the Mac MultiTower. It will run both multiuser A/UX Unix and a multiuser, preemptive multitasking version of the Mac OS with a zippy new Finder.

Prediction number 6: Even if I am wrong about all the specifics involved with my Apple "phoenix" scenario, I had better be right about the generalities it involves. If not, then Apple's survival, even as a niche computer company, is anything but certain.

Workstations Galore

Workstations are the single most interesting segment of the microcomputer market. Except for laptops, workstations are the fastest-growing portion of a market that has flattened overall sales in the past two years.

The serious workstation vendors—Sun, Hewlett-Packard, Apollo, NeXT, Tektronix, DEC, and now IBM—have figured out that higher-powered Unix-based personal computers networked together with Ethernet and Network File System (NFS) and running graphical user interfaces (GUIs) like the X Window System, Motif, and Open Look are where computing is heading.

The hot stuff in computing is workstation technology. More CPU power is now on your desktop. A local disk drive provides storage for some of your data, as well as backup capabilities, but most of your files and all your applications are stored elsewhere on a networked file server managed by the network. If you need more CPU power than your desktop machine can provide, the networked workstation system can tap the power of a CPU server that's been optimized for your specific needs.

Sun makes such systems, and, in fact, it is the leading vendor. But the workstation revolution is not of Sun's making alone. The fact is that you can build a hybrid networked system of workstations from several major vendors that will work as if they were all from one company. Although the reasons are simple, they bear repeating.

One, the primary operating system for any workstation network is System V Unix with Berkeley 4.3 extensions or some higher-performance variants (e.g., Carnegie Mellon University's Mach). Unix has been around forever, has been significantly enhanced over time, and has a large, vocal group of supporters.

Two, the glue for sharing files is Sun's freely available NFS. More than 78 vendor-specific implementations now exist.

Three, all the networking transport basics are provided by the tried-and-true Ethernet-compatible TCP/IP protocols. TCP/IP, like NFS, is freely available and has become an industry standard.

And four, a GUI that will work across all the workstations you have plugged into this network has been around for a few years in the form of MIT's X Window System, which is also freely available. This gives application programmers a standard interface to write for and makes your desktop look the same no matter what workstation you're on.

Apple has to become a major workstation vendor if it expects to survive. It should extend its Mac GUI into a version for A/UX and other non-Apple Unix implementations and peddle it as an X Window System–compatible alternative to Motif and Open Look. That extended Mac GUI should include the cross-platform development tools that programmers will need. Perhaps Apple should also license NextStep as part of this new workstation strategy (I'm *not* kidding).

Within five years, virtually all the computers that we place on our desks will be plugged into a network of some kind; in larger businesses, universities, and other institutions, these will be workstation networks. IBM's recent announcement of its RISC System/6000 line of RISC-based workstations points this out more than any other activity by a vendor in the past year. When IBM, a company that derives most of its revenues from large computers (mainframes, minicomputers, and its proprietary networks), says that Unix workstations are very important, it's time to listen. Apple should be listening, too.

Tip of the Month

MasterJuggler is one of my favorite utilities. A Suitcase II competitor, it lets you load as many fonts and desk accessories as you want without hacking away at your System file. Although its importance once System 7.0 is out is unclear (System 7.0 promises to rationalize DAs and fonts in a way that may make MasterJuggler unnecessary), its capabilities with the current Mac OS make it part of my daily Mac environment.

If you use MasterJuggler and have a Mac IIci, you've probably run into some intermittent memory problems when using MasterJuggler 1.5 (the latest major release). This seems to be related to the IIci's ROMs, System 6.0.4, and the way that MasterJuggler gets loaded into memory. According to ALSoft, MasterJuggler's creator, these problems can result in MasterJuggler not loading, an application crashing each time you use it, or aberrant behavior with different applications launched under MultiFinder.

I've run into a number of niggling little problems that mostly relate to not being able to load MasterJuggler at System start-up. I've also run into a conflict with the useful Boomerang shareware cdev. Boomerang adds some additional file management commands to Standard File dialog, making life with lots of files and applications much easier. Unfortunately, I can't run MasterJuggler 1.5 and Boomerang 2.0B9 at the same time.

I've given up using Boomerang for now because of these problems, since I need MasterJuggler more than I need Boomerang. When a new version of Boomerang comes out, I'll install it and see if that fixes this conflict. As to MasterJuggler and its intermittent problems with the IIci, I suspect that ALSoft will eventually pin down the conflict and issue an update to version 1.5. With MasterJuggler's sound- and FKEY-handling capabilities, I'll likely remain a loyal MasterJugglerist, even after System 7.0 has obviated the need for its font- and DA-handling features. ■

Don Crabb is the director of laboratories and a senior lecturer for the computer science department at the University of Chicago. He is also a contributing editor for BYTE. He can be reached on BIX as "decrabb."

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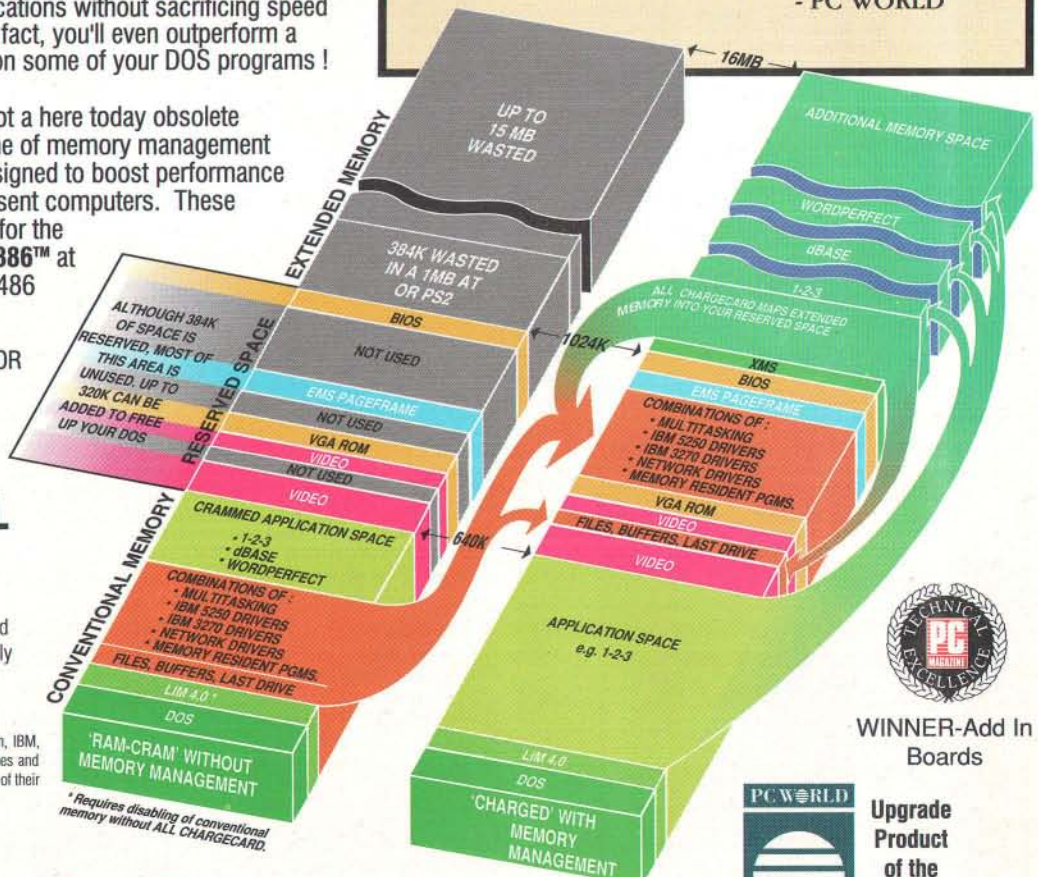

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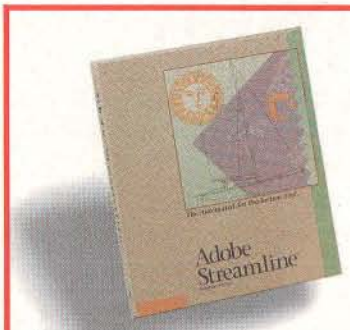

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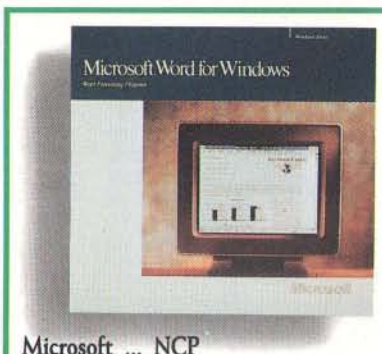

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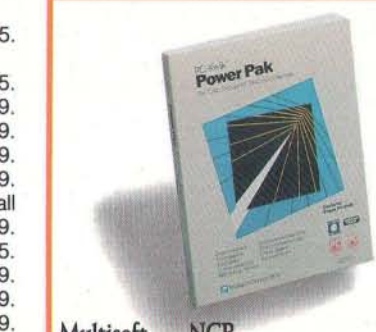

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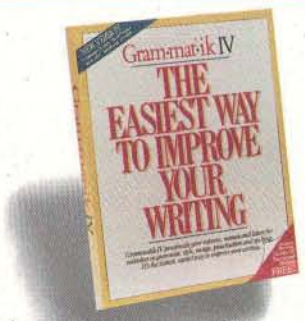

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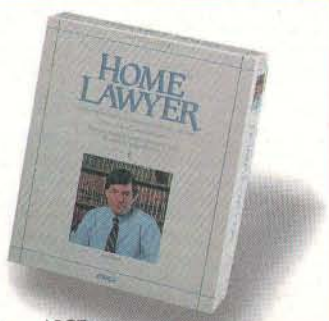

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Xerox ... NCP

3812 ☐Ventura Publisher 2.0 ..... 529.

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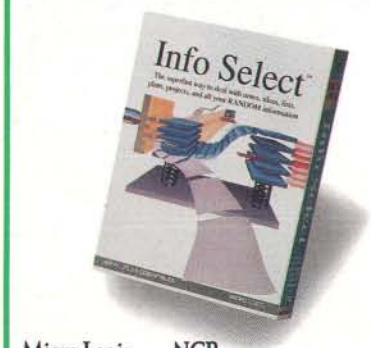

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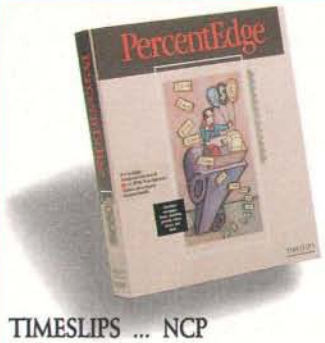

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3435 ◙My Letters,Numbers,Words *(2 to 6)* 22.
3438 ◙Young Math *(ages 5 to 8)* ..... 22.
3439 ☐2nd Math *(ages 7 to 16)* ..... 27.

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Manufacturer's standard limited warranty period for items shown is listed after each company name. Some products in their line may have different warranty periods.

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6812 200DL *(stand-by power source)* .. 155.
6811 360SX *(stand-by power source)*... 255.

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1299 SixPakPlus 384k C/S/P ..... 187.

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7001 BOCARAM/AT PLUS *(0-8 Meg ext.)* 135.
7000 TophAT *(16-bit backfill 512K to 640K, with 0K)* ..... 79.
6998 I/O Board for AT ..... 59.
6999 I/O Board for Microchannel S/S/P . 109.

Brother International ... 1 year

5787 HL-8e Laser Printer ..... 1799.
5788 HL-8Ps PostScript Laser Printer . 2949.

Compucable ... 2 years

1604 2-Position switch box ..... 25.

Cuesta ... 1 year

1608 Datasaver 400 Watt *(power backup)* 429.

Curtis ... lifetime

1694 Emerald SP-2 ..... 36.
1707 Ruby SPF-2 *(6 outlets)* ..... 55.
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Datadesk ... 3 years

6901 Switchboard ..... 175.

Diconix ... 1 year

5655 150 Plus Printer *(Parallel)*..... 359.

Epson ... 1 year

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1906 FX-850 *(80 col., 264 cps, 9 pin)* ... call
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6765 LQ-1010 *(136 col., 180 cps, 24 pin)* call
1917 LQ-1050 *(136 col., 264 cps, 24 pin)* call
4116 LQ-2550 *(136 col., 333 cps, 24 pin)* call
5184 LX-810 *(80 col., 180 cps, 9 pin)*.... call
1052 Printer-to-IBM cable *(6 feet)*..... 15.

5th Generation ... 1 year

3952 Logical Connection 512k..... 449.

Hayes ... 2 years

2307 Smartmodem 2400 ..... 349.
2308 Smartmodem 2400B *(w/Smartcom II)* 279.

Hercules ... 2 years

2318 Graphics Card Plus..... 189.

Hewlett-Packard ... 1 year

6754 LaserJet III *(w/toner)* ..... 1679.

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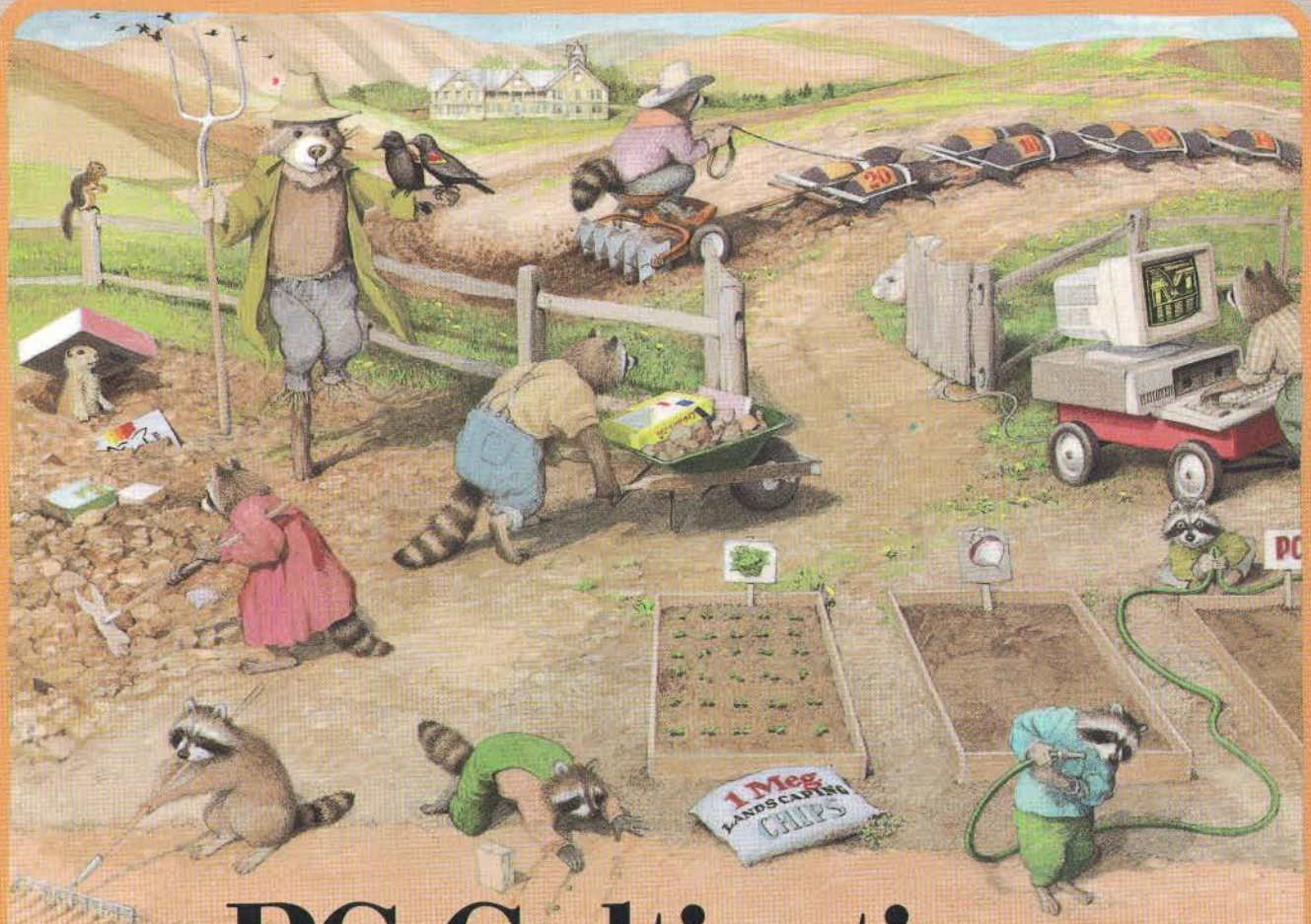

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2287 40 Meg Int. HD for PC ST251-1 *(w/controller and cables, 28 ms)* . . 419.

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2792 3½" DS/DD 720k Diskettes *(Qty. 10)* . . 15.
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2352	2400B Internal Modem 2 *(for PS/2)*	249.
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6797	TheComplete Fax Portable	319.
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6432	T1000SE Notebook Laptop *(5.9 lbs.)*	call
4958	T1600 Laptop *(12 MHz, 20 Meg)*	3249.
	Tripp Lite ... 2 years	
6199	Isobar 4-6 *(4 outlets, 6 ft. cord)*	49.
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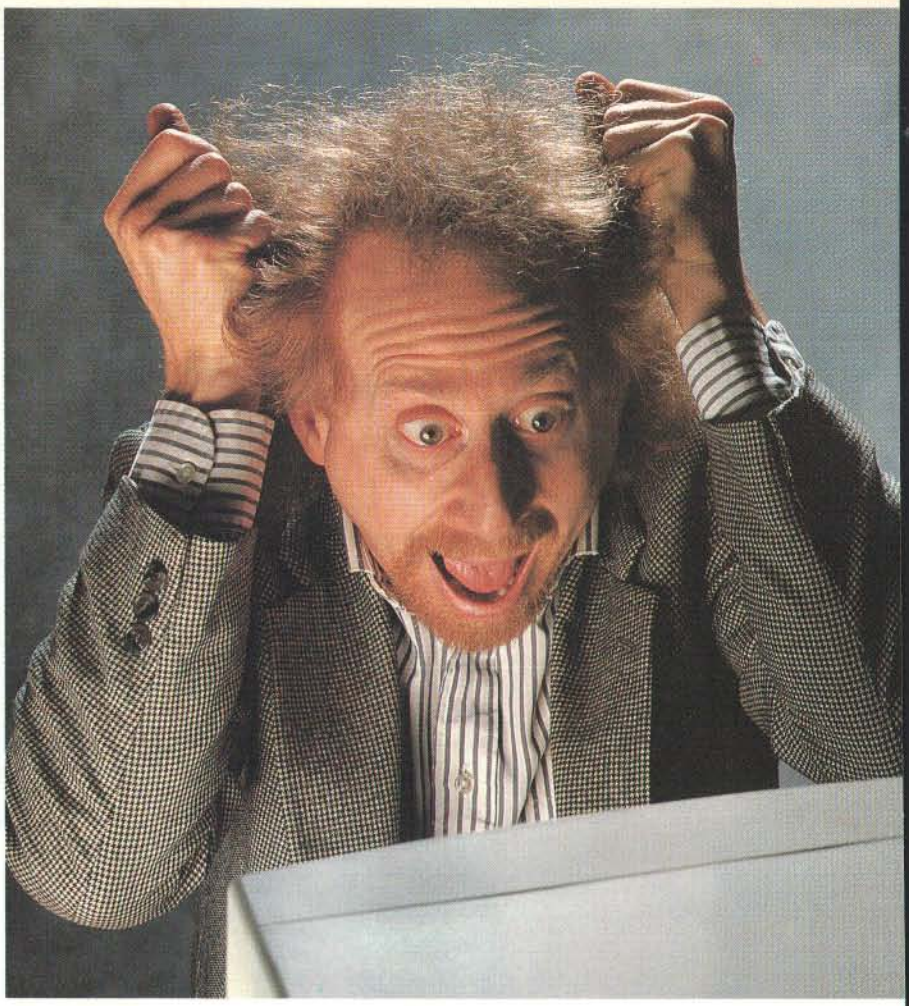

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Byte Magazine, May 1989

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FREE SOFTWARE!

What is it, how do you get it, and how good is it?

Free software: The concept boggles the mind. In this money-conscious day and age, can there really be anything free that's worth any more than what you pay for it?

In the world of Unix, the answer is a resounding yes. Much of Unix culture is built around the concept of sharing ideas—think of the "group" permissions as only one example—and sharing software is a natural extension of this. Unix itself grew out of a project that (at the time) had no commercial intent or value: The people working on it did it for the pleasure of building something worthwhile. Berkeley Unix came about because more people contributed other pieces of code that they thought would benefit the Unix system. Today, we use `vi`, `uucp`, `emacs`, Usenet, `compress`, and many other programs whose origins are of this nature.

So what does "free" really mean? There are varying degrees of freedom in software, as in physics. The most free software is public domain, which means the author explicitly relinquishes the copyright, and the software belongs to anyone who wishes to use it in any way. Although it is morally bankrupt to do so, you could legally sell public domain software for stiff fees as if you owned it (to people who presumably didn't know any better). There is a fine line here, wherein there are companies who distribute public domain software for a small profit above their copying costs; this is generally considered a "fair use."

Then there is shareware, which is software written to make money, but which buyers can copy freely for others. The distinction is that anyone who takes a copy of the software is expected to send a fee to the author. Shareware is quite common with PCs, but it is relatively rare with Unix. Part of the reason may be that PC shareware is almost always distributed in binary form, but Unix software tends to be source code, and most people who are expecting to receive money don't want their source code in others' hands.

In between these two concepts, and where most "free" Unix software falls, is what might be termed *freely available* software. This is software that the author has chosen to make available freely to all, but he or she retains the copyright and therefore the ability to control it. Most software distributed on the various Unix networks is of this kind. A notice states the author's name and copyright, followed by the restrictions, if any, that have been placed on the program's use or further distribution. I've seen at least one program whose author restricted its use to nonmilitary sites (and always wondered whether that author made use of `pcomm`, written by Emmet Gray at Fort Hood).

On-Line Archive Sites

I could easily fill dozens of pages with an annotated list of the freely available, useful software that has been posted to Usenet over the last year alone. Suffice it to say that you should try to get access to Usenet (see last month's column) or Internet if you want to keep up with all that is going on.

Even a list of archive sites, whose operators allow other users free access to their file collections, would be far too long, but you can get that list directly from me (see below). BIX itself has a good deal of C and Unix software available on-line, including GNU material, where it can be downloaded by anyone with a modem.

continued

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What's GNU?

Any discussion of free software would be incomplete if it did not mention GNU, a project of the Free Software Foundation. The FSF was started by Richard Stallman, a computer scientist, AI expert, and visionary who also serves as its president. The GNU project is nothing less than an attempt to create a software package that is upwardly compatible with Unix and will be freely available.

A few years ago, some people treated GNU as little more than a joke—a few hackers in a basement with nothing but a dream. The few have grown to many, and the dream has grown to encompass GNU EMACS, GDB (a source-level C debugger), Bison (a `yacc` replacement), the GNU C compiler (a full ANSI version better than many commercial compilers), Ghostscript (a PostScript interpreter), and quite a few other complete packages. The GNU kernel itself is not currently being worked on, since it is anticipated that Mach will soon be available freely as a base (there are a number of other alternatives if this doesn't happen).

The point is that FSF's dedication has paid off with software at a professional, not hobbyist, level. Once the GNU system is complete, anyone will be able to run a Unix-compatible system free and have the source code as well. GNU software is protected by "copyleft," a legal instrument that permits anyone to obtain a copy of the software, along with the right to distribute other copies and the ability to modify his or her copy (which implies source code). It also prevents you from denying these rights to others. The idea is that any software based on GNU work must also be freely available in source form.

The FSF is a 501(c)3 charitable organization under Internal Revenue Service rules and is a very worthwhile organization. While you can retrieve GNU software from one of the many archive sites, those in the position to buy tapes with this software should do so: It's less load on the network, and it provides the FSF with some additional funding.

The 24-page *GNU's Bulletin* is available directly from the FSF. While it is free, it costs them money to print and mail it, so please send them a couple of dollars if you request one. You can contact them at the following address:

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Free Printout Foundation

A great many people want to access some of this free or freely available software but don't know exactly where to find it, and I'd like to help them out. So if you want a printout of dozens of dial-up public-access Unix systems and archive sites, many of which have such source code available on-line, send a business-size (#10) self-addressed stamped envelope to me (with 45 cents postage), and I will send you a copy (it's the `nixpub` list mentioned in last month's column, with a few additions). Outside the U.S., please send sufficient International Reply Coupons to cover 2 ounces. Requests without proper postage will be sadly forwarded to `/dev/null`. Use the following address only: InfoPro Public Access, P.O. Box 220, Rescue, CA 95672. And please be patient; I'm printing and sending this information on my own time and money, and I'll do it as fast as I can. [Editor's note: *The* `nixpub` *list is also available on BIX and on disk. See page 5 for details.*]

What Good Is It?

Many people start collecting free software and soon run out of disk space, as well as time to compile and test it all. This is a particular problem endemic to authors who write columns about free software, although almost anyone is susceptible. Thankfully, most software that is found on the various networks is well written, and you almost always get source code. While this doesn't guarantee that you won't get a virus attack (how many people scan every line of a 14-part posting?), it means that you can at least decide to be responsible for your own safety. Some people advocate playing it safe by not running anything until a month after it has appeared, assuming that if it causes problems, someone else will have reported it by then.

My own method involves not even *compiling* it until a few weeks have elapsed. I often do `grep` searches for `system` calls and the letters `uid` in the code, and I am extremely suspicious of programs that "must" run in `setuid` mode (which opens up all kinds of potential security holes). But the real reason is that patches to every wonder program usually show up within a few weeks. These patches invariably fix minor bugs such as "will no longer scramble free list" or "now functions properly on machines other than IBM PCjr." There's just no sense working madly to get a program running when the patches will come along and wipe out your changes.

Some might say that this is a selfish attitude: If everyone felt this way, who would submit the patches, or even write the programs in the first place? Well, I've paid my dues by contributing programs and fixes to the network, so I have some sort of moral position, personally. The fact is that there are people who enjoy fixing code, and others who absolutely *need* these programs for their work, and they derive a definite benefit from it. By all means, feel free to submit your own fixes to the network if they work. You might save someone else a great deal of time.

And time is what you may well need once you get hooked. While there are a few programs that you can just put into a directory, type `make`, and reap the benefits of instantly, they are actually few and far between. Most packages are not written with portability in mind; they were written to solve someone's problem, and the authors are sharing their work with you. In fairness, I would say that 80 percent of the software on the network will work fine on a more-or-less standard system after 5 minutes of editing the make file and maybe a header file or two. This, of course, presupposes that you know how and what to do. If not, there's often a README file that will give you hints. If that fails, you can always get clues from the C compiler's error messages. Many of the largest programs, in contrast, are so well written that they run through their own configuration by examining your system; Larry Wall's work is especially notable here.

Which brings us to the real question again: Is it even worth bothering with free programs in the first place? My answer is a definite yes. I have more programs in one of my "free" directories than I do in `/bin`. While quantity is not the ultimate arbiter, I would not even keep the binaries around if I didn't use the programs. Frankly, I wouldn't want to imagine what my computing life would be like without free programs, not even counting things like `vi` and Usenet.

Next month, I'll go into some programs that I've found to be useful or interesting. And perhaps I'll give a few of my own hints on how to blast through those make files in less than 300 seconds. ■

David Fiedler is executive producer of Unix Video Quarterly *and coauthor of the book* Unix System Administration. *He has helped start several Unix-related publications. You can reach him on BIX as "fiedler."*

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

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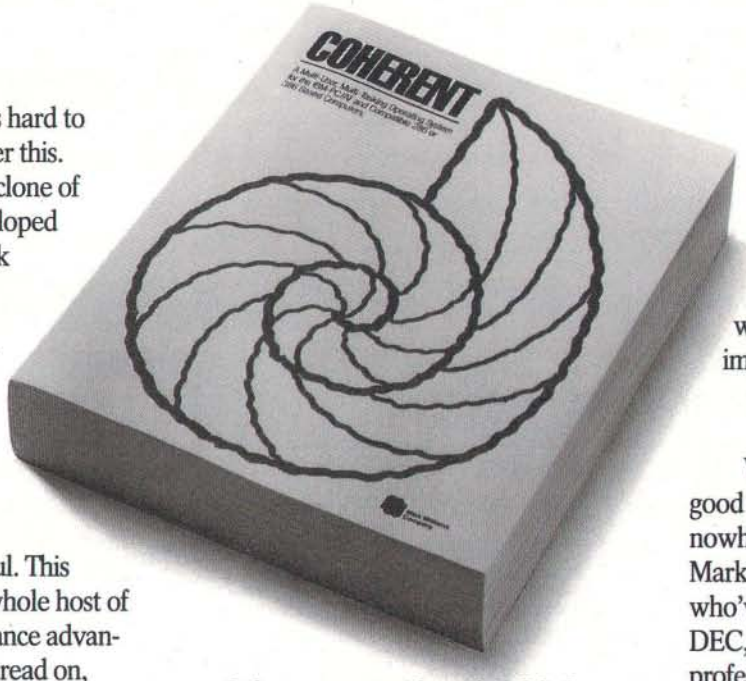

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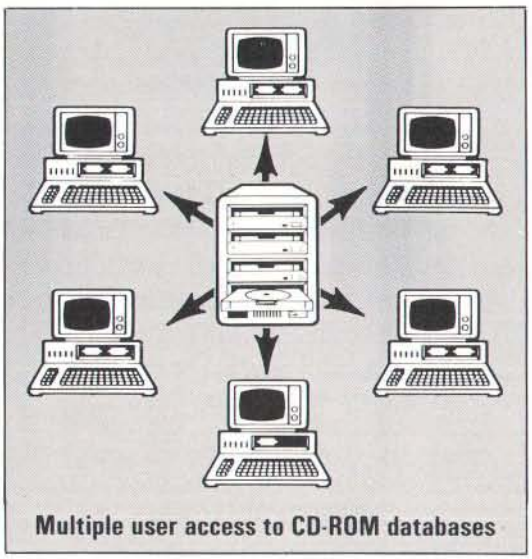

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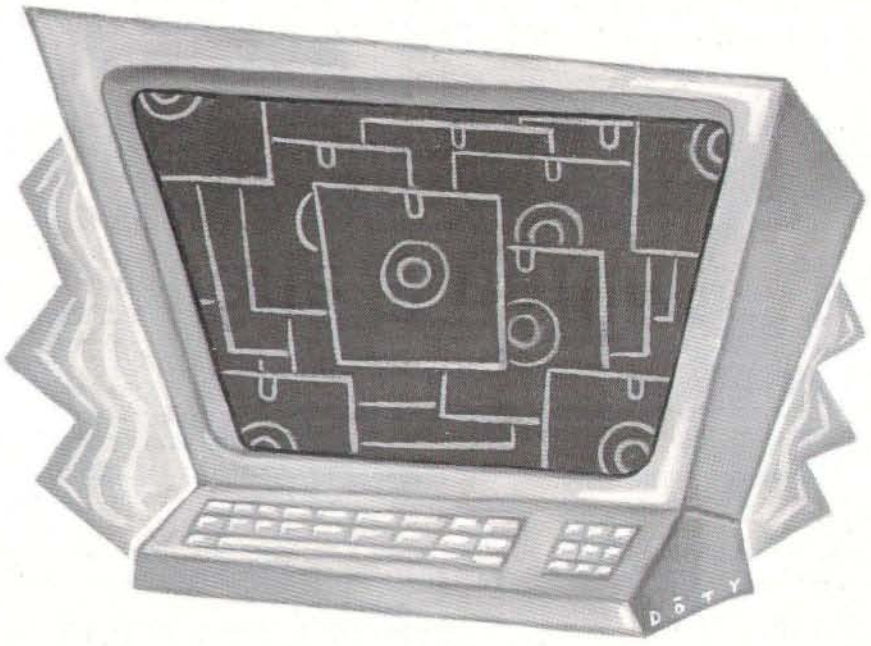
OS/2 MARRIES DESQVIEW

The kids are called virtual DOS machines



I have seen the developer's version of Microsoft's OS/2 for the 386, OS/2 2.0. And there's very good news: It addresses many of the problems with current OS/2s. Here's a summary of what I learned at Microsoft's rollout demonstration. The headline features of version 2.0 are the following:

- supports multiple DOS sessions, or virtual DOS machines (VDMs)
- requires a 386SX, 386, or i486 chip
- uses the 386's "flat" memory model
- runs version 1.x software—despite radical changes under the hood—including, thank heaven, device drivers

Some lesser features of version 2.0 include the following:

- runs more concurrent programs than under version 1.x
- restructures interprocess communications, particularly semaphores
- makes future ports to RISC more likely, thanks to the flat 32-bit memory model
- supports limited cut-and-paste capabilities for DOS programs run in a VDM
- greatly improves free space for DOS programs

Multiple DOS Machines

I've long believed that one of the major stumbling blocks in the way of OS/2's success is its limited support of DOS applications. Back when "DOS 5.0" was first being touted, IBM and Microsoft led us to believe that it would not only run new protected-mode programs, it would also run existing DOS programs—and several of them at the same time. OS/2 2.0 will finally redeem that promise: Microsoft showed Lotus 1-2-3, WordPerfect, and Flight Simulator all running simultaneously in Presentation Manager (PM) windows. Each DOS session is called a VDM.

The three programs were all normal DOS applications, not special OS/2 versions. And they seemed to run pretty well, except for the graphically intensive Flight Simulator, which merely crept along on the 33-MHz 386 being used for the demonstration. Seeing several DOS applications all running in PM windows looked a lot like DESQview, with the added benefit that graphical applications could be windowed. Whether or not it is as sturdy as DESQview won't be clear until the final release of version 2.0 later this year.

More interesting are the results when CHKDSK runs. A DOS application gets about 610K bytes of free space, more than under DOS 3.3 or 4.0. VDMs get HMA (high memory area) support, so Windows/286 in a VDM would have a huge amount of all-important conventional memory available to it. (This is becoming less important, of course, as more and more of the big Windows applications move to the wide-open spaces of the PM.)

Like other 386-based DOS multitaskers, version 2.0 can also give a VDM access to a chunk of extended memory, disguised as EMS 4.0 expanded memory. Unlike a DOS program running in the version 1.x compatibility box, a program running on a version 2.0 VDM can swap out of memory.

DOS Multitasking Is Possible

All this is possible, of course, because version 2.0 requires a 386-family (i.e., 386SX, 386, or i486) chip to run, and the

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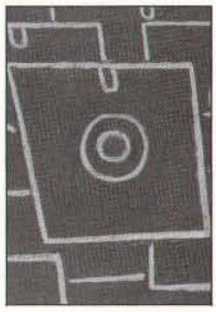
The big news is that the Hewlett-Packard LaserJet drivers are finally on Device Driver Disk 2.



386-family chips include a virtual 8086 (V86) mode that, used properly, can support essentially bulletproof DOS multitasking. The 386 has a *page-mapping* capability that lets OS/2 hand portions of memory to DOS applications, yet makes each DOS application think it's the only program in the system. The 386 can even support multitasking of most "badly behaved" applications. To see why, here's an example.

Ordinarily, DOS runs in the low 640K bytes of a PC's memory. Just above that area, from 640K bytes to 768K bytes, lies the video RAM (VRAM), which holds the current image on the video screen. Most DOS programs, in order to gain speed, write information directly to that video memory. Such an action is one example of being badly behaved, and it's a headache for a multitasker.

Imagine the mess you'd have when trying to simultaneously run a bunch of programs that are all writing directly to the VRAM. If you ran dBASE while Lotus 1-2-3 was recalculating in the background, you might end up with a dBASE screen with the 1-2-3 "Wait" message flashing in the upper right-hand corner of the screen. (The message might actually be appropriate if you were running dBASE, but that's another story.)

Here's how the 386 avoids this. Its page-mapping capability lets it control what memory each program can see. Thus, a 386 operating system like OS/2 2.0 can, for example, remap 128K bytes of memory actually located in the fourth megabyte of RAM so that a DOS application in the background thinks that memory is the video buffer. The DOS application, running in the background, can merrily write to its virtual video board. When the application comes to the foreground, a change in the page-map tables connects that 128K bytes of RAM to the actual video memory address, thereby presenting the program's screen to the user.

You may have heard of video boards being "register-compatible" with IBM boards. This refers to I/O addresses, and these too are remappable under the V86 mode. Microsoft has included code in OS/2 2.0 to handle most common I/O devices. These entities are called virtual device drivers. VDDs exist for the basic devices—printers, the screen, and the mouse. And there are also VDDs for some not-so-basic devices. A DOS application running in a VDM will still be able to program DMA and the timer and do low-level floppy disk access.

Of course, some things will not be permitted—most specifically, low-level hard disk twiddling. Imagine what kinds of disasters could happen if you modified the file allocation table with Norton Utilities while an OS/2 application in the background updated a database. You'd have a FAT image in the memory, and then you'd tell Norton Utilities to write it to disk. Once Norton Utilities wrote out the modified FAT, all the work that the background OS/2 program had done would be down the drain. That's why there's no VDD for low-level hard disk access.

Microsoft has even indicated that it has a process in place for letting third parties build their own VDDs to support their own devices. And yes, there will be a development kit for this purpose—called, of course, a VDDDK.

Finally—LaserJet Drivers!

Those people who sent in their IBM OS/2 registration cards will have received from IBM an OS/2 1.2 update. The big news is that the Hewlett-Packard LaserJet drivers are finally on Device Driver Disk 2.

But there's a trick to using the new drivers. You must reinstall OS/2 altogether, or else the Control Panel won't recognize them. If you use Dual Boot, just reboot under OS/2 and install the new copy of OS/2 1.2. Once it's all installed, you'll find that Dual Boot still works and can bring up DOS without any trouble.

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ITEMS DISCUSSED

Brief $199
UnderWare, Inc.
321 Columbus Ave.
Boston, MA 02116
(617) 267-9743
Inquiry 983.

Qedit $79
SemWare
4343 Shallowford Rd., Suite C-3
Marietta, GA 30062
(404) 641-9002
Inquiry 984.

Text Editor Update

Before I go, here's an editor follow-up. I've been complaining about the lack of text editors for OS/2, or, more specifically, text editors that can be made to look like my old faithful IBM Personal Editor. PE is not coming out for OS/2, so I've been trying out candidates to replace it. Here are the best two I've come up with so far.

UnderWare's Brief is fantastic, and it's a favorite of many programmers. I've been a bit leery of it only because of its power—I figured I'd never have time to learn all the things that it can do. But I'm working with it a bit at a time and am enjoying its speed and extensibility. I recommend it to anyone needing a powerful editor that will work the same under DOS and OS/2.

I find myself using SemWare's Qedit quite a bit, not so much because of its power as because of its ability to change personality. I've almost completely retrained it to behave like PE. It has many of PE's strengths and weaknesses. For example, the search-and-replace command doesn't have the grep-like power of Brief.

Qedit also can't restrict a search/replace to the marked block, the macro language is spare, and I miss being able to mark a block and fill it with a character. But it has a built-in sorting capability and a box-drawing mode that is nothing short of fantastic. Add that it's memory-parsimonious (48K bytes), fast, and cheap ($79), and it's all in all a good buy. ■

Mark J. Minasi is a managing partner at Moulton, Minasi & Company, a Columbia, Maryland, firm specializing in technical seminars. He can be reached on BIX as "mjminasi."

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

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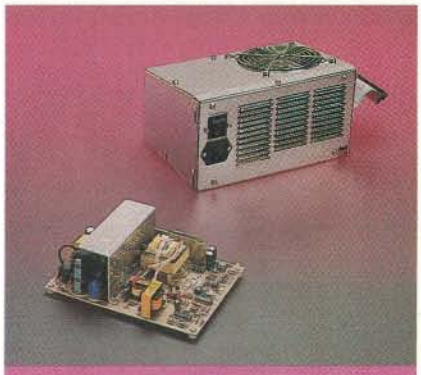

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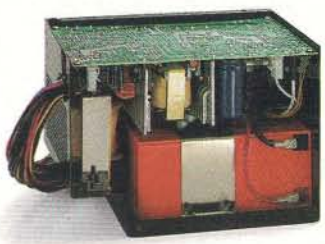

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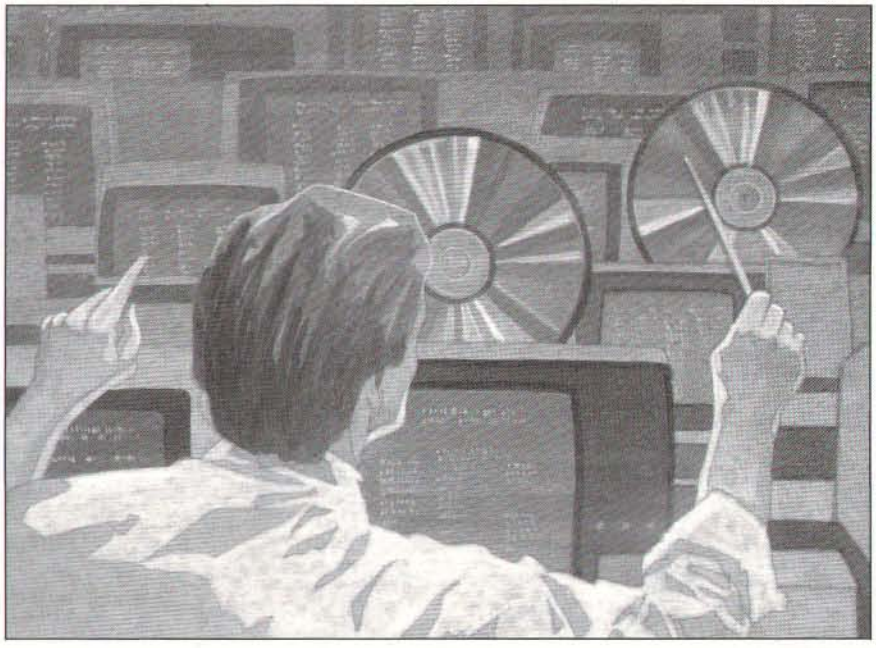
A NATURAL MATCH

Sharing CD-ROMs on a LAN is a natural idea, but it's still a little harder than it should be



CD-ROMs and LANs are a natural match. Although CD-ROM drives and disks are still too expensive for most desktops, LANs let you spread those costs among many users. Unfortunately, to share a CD-ROM drive, you typically have to do more than just hook the drive onto a computer on your LAN.

The Problem

CD-ROMs pose problems for LANs. The biggest one that CD-ROM disks don't behave like normal disks.

Because the huge capacity of CD-ROM disks far exceeds the traditional DOS limit of 32 megabytes, Microsoft wrote special software to handle CD-ROMs. That software, the Microsoft MS-DOS CD-ROM Extensions (MSCDEX), is a DOS file redirector that intercepts BIOS read and write requests that involve CD-ROMs and handles those requests itself. Unfortunately, many LANs also use redirectors to provide remote access to shared hard disk drives, so they end up trying to redirect a redirector when they work with a CD-ROM drive.

Server-based LAN operating systems typically can handle very large hard disks, so they could avoid the redirector hassle entirely by attaching the CD-ROM drives directly to the server—but they lack the drivers that they need to make their servers work with CD-ROM drives. Without those drivers, server-based LANs must attach the CD-ROM drives to a microcomputer on the LAN.

Peer-to-peer LANs, which have no dedicated servers, also must work with CD-ROM drives on LAN systems. Each client system must therefore run two redirectors—the one that the LAN requires, and MSCDEX. That task is certainly possible (it's similar to stacking TSR programs), but it's also easy to get wrong. Some peer-to-peer LANs, such as LANtastic, avoid this approach altogether by providing explicit support for CD-ROM drives.

Software products like Map Assist and Pipes can give peer-to-peer features—including the ability to share a workstation's CD-ROM drive—to server-based LANs (see "Adding Peer Services to a Server-Based LAN" on page 146). We'll concentrate instead on two other types of products that let you add CD-ROM services to your server-based LAN.

Different on the Outside

One class of products uses a dedicated CD-ROM server system that you attach to the LAN. CBIS's combined CD Server hardware amd CD Connection software goes this route. The dedicated CD Server system, which resembles a tower-style PC, sits on a LAN and does nothing but let you use its CD-ROM drives. This monolith can house up to seven CD-ROM drives, and you can add up to seven more drives in a second cabinet. The minimal system comes with one CD-ROM drive, a 12-MHz 286 CPU, and 2 MB of memory, for which you must pay a whopping $5300.

If you have many users, however, you'll probably want additional drives, and you'll definitely want more memory. CD-ROM drives are slow, so the more memory you have for data caching, the faster your overall performance will be. With several users, you'll want at least a couple of extra megabytes of memory.

You can run the CD Connection software on any NetBIOS-compatible LAN operating system, and on NetWare's IPX—which lets you avoid the overhead

continued

ILLUSTRATION: GORDON HAAS © 1990

of forcing NetWare to run NetBIOS.

The other way to provide LAN access to a CD-ROM drive is to hook a standard single-user CD-ROM drive to any PC on the LAN and then install software that lets anyone on the LAN use that drive. That's the approach of Online Computer Systems' Opti-Net.

Opti-Net handles up to 24 CD-ROM drives at once, and Online Computer Systems sells a four-drive box. We tested the product with a standard external Sony CD-ROM drive. What you pay for Opti-Net depends on how many users you have. An eight-user version runs $795; $1495 buys a 100-user license. Like the CD Connection software, Opti-Net can run on any NetBIOS-compatible LAN or directly on NetWare's IPX.

Opti-Net itself is just software, but to use it you need both a CD-ROM drive and a LAN PC to which you can connect that CD-ROM drive. Fortunately, you don't have to dedicate that PC to the task of providing CD-ROM access. The usual server caveats apply, however: As more users share the CD-ROM, the server PC becomes increasingly sluggish doing anything else.

Alike on the Inside

Although the large tower of the CD Server and the standard, typically small CD-ROM drive of an Opti-Net system look quite different, the two setups are very similar beneath the surface.

On the hardware side, both use DOS PCs (the CD Server's 286 CPU runs its software on top of DOS, just as any normal PC might) and CD-ROM drives.

Their software is also similar. Both start with CD-ROM device drivers. Opti-Net adds a second device driver that makes the CD-ROM drives available to LAN users. Both products then run MSCDEX. On top of this base, with both products you must run your standard LAN software. (We used NetWare.)

The next step is to run the software that lets everyone share the CD-ROM drives, but exactly what you run depends on which package you're using.

You first run Opti-Net on the server PC and then mount and name individual CD-ROM disks. To get to those disks, each client PC also has to run special software. After loading MSCDEX and the usual network software, each client system must run a program called ONET and then specify the disk or disks it wants to use. Those CD-ROMs then look and act like huge read-only disks.

Setting up and using the CD Server is a similar process, but the CD Server does not have a hard disk. You must, therefore, put the CD-ROM driver software, MSCDEX, the network software, and CBIS's CDSERVER program on a 1.2-MB floppy disk that you'll use to boot the CD Server. (You run MSCDEX and the CDSERVER program in that disk's AUTOEXEC.BAT file.) To use the CD Server from a client LAN PC, you run the CDREDIR file redirector program and then run CDUSE to mount the CD-ROM drives.

A Hybrid Approach

Things are different on a Mac: Apple's CD-ROM-sharing technique combines a bit of each of these earlier methods.

As with Opti-Net, you use a standard Macintosh CD-ROM drive. But, as with the CD Server, you must attach that drive to a Mac that is acting as a dedicated AppleShare file server. That Mac can still provide normal AppleShare server

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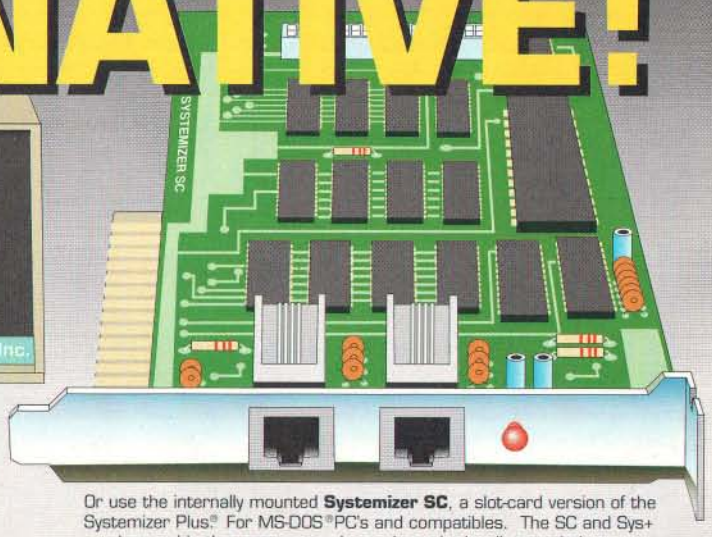

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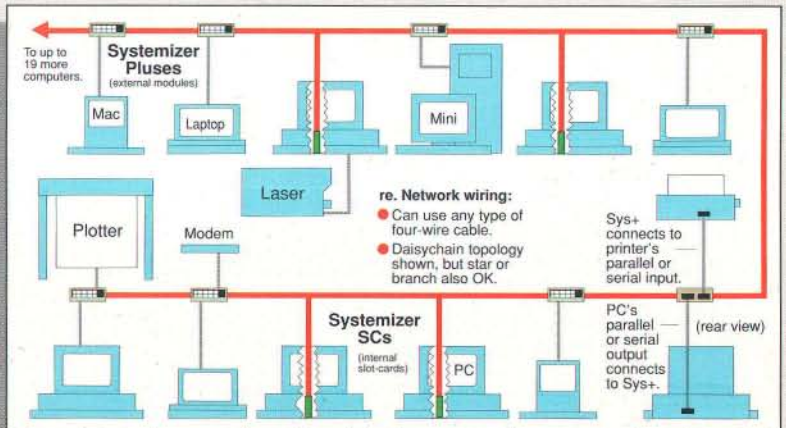

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features, such as hard disk sharing.

Installing the necessary driver software is simple: just click on the CD-ROM installer program, which then drags the necessary CD-ROM driver programs into your server folder. (Apple calls the standard system folder on an AppleShare server the "server" folder.)

The only hassle is that you have to "prepare" each CD-ROM disk that you might want to use by running the AppleShare Administration program on the server when that disk is in the CD-ROM drive. Once you've done that, however, the CD-ROM is available to every Mac on the LAN. The client Macs don't have to run any special software; it all just works. The PC world still has a long way to go in this area to match the Mac.

One Drive, One CD-ROM

Whether you're using a Mac or a PC LAN, you can't just pop CD-ROM disks in and out like floppy disks.

On the Mac, before you insert a new CD-ROM disk, you have to prepare that disk, which means taking down the server, running the Administration program, and starting the server software again. You can prepare lots of CD-ROM disks at once, but a new one still leads you back to this unfortunate process.

Things are not much better on PC LANs, where to change the CD-ROM in a drive you must first dismount the current disk and then mount the new one.

The bottom line is that it's best to plan on one CD-ROM drive per disk that you plan to share regularly. You can switch disks, but it will be a hassle. We don't much like this working philosophy, but it's clear that you don't want somebody popping out the CD-ROM disk that you are using and sticking in a different one.

A Few Other Problems

CD-ROMs have other problems. The biggest one is lack of speed. While high-capacity hard disk drives are driving access times below the 10-millisecond mark, CD-ROM drives are still battling the 300-ms barrier.

On the PC, memory consumption can also be a problem. By the time you add to your standard LAN software and TSR memory overhead the 23K bytes or so of MSCDEX and the roughly equal (or greater) memory that the CD-ROM LAN-access software requires, there's usually well under 512K bytes of memory left for applications.

Finally, several CD-ROM vendors make you pay something extra for LAN use; Ziff Communications, for example, charges an additional $75 over the base cost of its Computer Library CD-ROM for each LAN user, while Microsoft hits you for $65 per additional LAN client.

Despite these problems, we're still excited about all three of these CD-ROM products in particular, and the CD-ROM/LAN match in general. We plan to use CD-ROMs on our LANs regularly. But we're not as excited as we were originally. This technology, like much of today's LAN software, is better in concept than in implementation. Eventually, the reality will catch up to the dream; we can't wait. ■

Mark L. Van Name and Bill Catchings are BYTE contributing editors. Both are also independent computer consultants and freelance writers based in Raleigh, North Carolina. You can reach them on BIX as "mvanname" and "wbc3," respectively.

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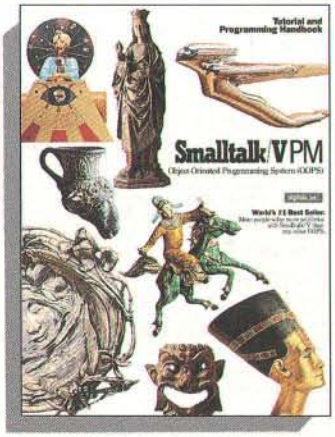

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Smalltalk/V

SHORT TAKES

BYTE editors' hands-on views of new and developing products

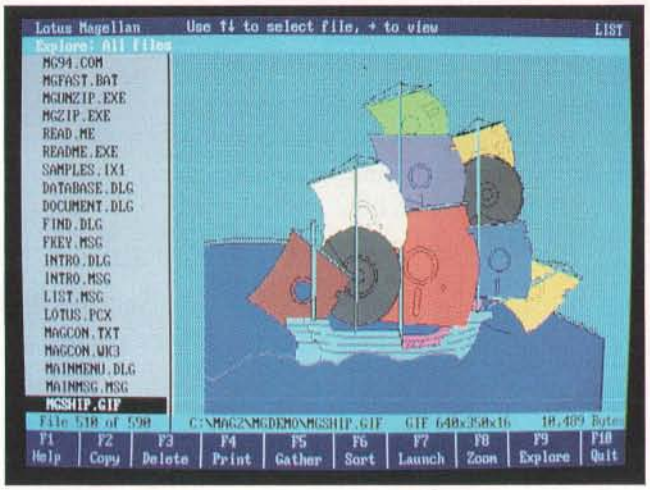
Magellan 2.0

PageMaker 4.0

Ergo Model 1: The Brick

Programmer's Toolkit

Full Impact 2.0



The Second Voyage of Magellan

Conventional wisdom says that you should never buy the first release of any software package. The second release of Lotus Development's Magellan underlines this truism. Not that the first release was buggy; but **Magellan 2.0** is a vastly expanded and eminently more capable package that takes "intelligent DOS shells" to a new plateau of functionality.

The folks in Cambridge haven't fooled with the basic Magellan interface. It still presents you with a list of your files (sorted in whichever way you choose) on the left side of the screen and a view of the contents of the file on the right.

In Magellan, the concept of views is a crucial one. Greatly enhanced in version 2.0, Magellan's viewers let you quickly browse through files and view their contents the way you see them from within your application (e.g., a Lotus 1-2-3 spreadsheet looks like a spreadsheet instead of a jumble of characters, and a WordPerfect document is correctly formatted).

There are a bunch of handy new viewers in version 2.0; and the inclusion of viewers for such venerable applications as Excel, Paradox, and Quattro make this new Magellan even more useful. There's even a viewer that lets you view a deleted file before you unerase it. And what's even more useful is the integration of viewers for graphics files. If you point to a file created by a package like Freelance or PC Paint, you actually see the graphic on your screen—instantly.

What really sets Magellan 2.0 apart from the first version is file compression. Lotus has licensed PKWare's ZIP technology, which does a particularly classy job of archiving groups of files while cutting your file storage space needs by up to 50 percent. In the new Magellan, you mark files, press a key, and ZIP (compress) them into a fraction of their former selves. And the reverse holds true for the UNZIP (decompression) process.

But wait, there's more. In Magellan 1.0, I could see a directory of the files in my archive, but I couldn't go beyond that. Magellan 2.0's new nested viewers are truly unique. I can call up a ZIPped archive, see a list of the files contained within it, and actually view the contents of the files, with Magellan figuring out which viewer to use from within the ZIP viewer. Taken all together, this makes archiving files a much simpler process. If your hard disk is getting full, nested viewers can be a lifesaver.

Magellan 2.0 also has a multitude of additional new features. There's a file/disk/archive backup-and-restore facility, file verify-and-compare capabilities, and numerous new ways that you can customize how you and Magellan 2.0 interact with your valuable data. And the setup process is slyly intelligent, automatically figuring out essential details (e.g., the printer you have installed) from the contents of the files already on your drive.

Although Lotus markets Magellan as an all-purpose, always-resident intelligent DOS shell, I've never been comfortable using it that way. That doesn't mean that it's not valuable as a DOS shell. However, I believe that how you interact with DOS is a matter of personal taste.

I've found that Magellan's ability to index and locate all the data on all my hard disks is the shining feature that I can't live without. And it's even better in version 2.0. Magellan took over 60 megabytes of programs and data on my hard disk and created a 2-MB index. Couple the viewers with Magellan's newly expanded "fuzzy search" capability, and it becomes absolutely invaluable for locating data that's tucked away someplace but you don't know where.

What Magellan 2.0 has brought to the DOS world is a unique ability to see your data as an integrated and accessible knowledge base instead of just a loose collection of files. I particularly like the way it treats multiple hard disk volumes as a single entity. And while the basic Magellan interface may not be your ideal cup of tea, the package is versatile and customizable enough to make the voyage enjoyable.

—Stan Miastkowski

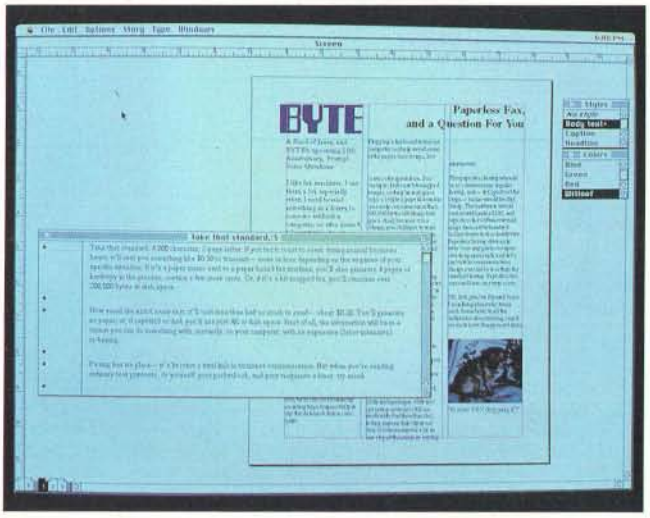
THE FACTS

Magellan 2.0
$139

Requirements:
IBM PC or compatible running DOS 3.1 or higher with at least 256K bytes of RAM and a hard disk drive.

Lotus Development Corp.
55 Cambridge Pkwy.
Cambridge, MA 02142
(617) 577-8500
Inquiry 985.

PageMaker Never Looked Better



With **PageMaker 4.0**, the loose ends in the previous versions are almost all cleaned up and several features are added that fans have been wanting for years. The result is a nearly perfect desktop publishing program for the Macintosh.

The Preferences menu selection now boasts a text-only display mode as well as a monofont story editor. Editing story text used to be a pain. The story editor brings up the selected story in a single font and gives you the usual amenities: cut and paste, a full spelling checker, and improved hyphenation. Text import and export filters convert PageMaker stories to and from popular word processors. TIFF support is now expanded to include both compressed TIFF files and 24-bit color images.

There are other additions, too, like the ability to toggle between the selection tool and the currently selected one by pressing Command–Space bar. Also, you no longer need to be an octopus to capture PostScript output. Instead of Command-option-K, the "PostScript" button in the Print menu gives you direct file output.

New font support allows rotating text in 90-degree increments and has drastically improved font kerning and point control. Maximum font size is increased from 127 points to 650 points. New paragraph controls include selectable orphan and widow functions and automatic placement of rules at the beginning and end of each paragraph.

For large publications, the new Book functions let you group multiple documents together into one logical entity. It's especially handy when you combine it with the new table of contents and indexing features. The maximum document length has been expanded to 999 pages.

I worked with a beta version on both a 4-megabyte Mac SE and a 5-MB Mac II with a Radius dual-page color display. Before I could run PageMaker 4.0 on the Mac SE, I had to upgrade the standard 1 MB of RAM. Aldus recommends a minimum of 2 MB. With 4 MB, PageMaker 4.0 ran perfectly under MultiFinder 6.0.3 with Adobe Type Manager, leaving 1.5 MB free, which was ample room to fire up Microsoft Word 4.0. Speedwise, the new PageMaker takes a little longer to display text than version 3.0, but it's fast enough to be usable on a Mac SE. Printer output is much improved, thanks to the new kerning and tracking features.

What I'd still like to see added are multiple document windows and more complete "export" tagging. It would be great to save text attributes when converting to or from ASCII documents. Nevertheless, PageMaker 4.0 is almost all you could hope for in a desktop publishing package.

—Howard Eglowstein

THE FACTS

PageMaker 4.0
$795; $150 upgrade fee for registered 3.0 users

Requirements:
Mac SE or better with 2 MB of RAM and a hard disk drive with 6 MB of free disk space.

Aldus Corp.
411 First Ave. S
Seattle, WA 98104
(206) 622-5500
Inquiry 986.

The Granite-Sided Brick from Ergo Computing: Transportable Technology

The computer industry isn't very creative about product names, so I have to hand it to Ergo Computing for aptly nicknaming its system **Ergo Model 1: The Brick**. The Brick is a loaded 16-MHz 386SX-based system packed in a 3⅓- by 8- by 11⅓-inch package that weighs 7½ pounds. (A 20-MHz version is coming later.) But the resemblance to a piece of masonry doesn't end there; The Brick comes standard in an eye-catching granite-finish case. (For the less adventurous, it's also available in boring beige.)

The philosophy behind The Brick is so obvious that I'm surprised that no one has thought of it before. While laptops are popular, they don't always fill the bill for today's busy computer-literate work force, who need to take work home in the evening. With The Brick you can keep a monitor and a keyboard at each work location, carrying the computer guts (and your own data) between locations. The Brick takes up less than half of a typical briefcase and is built to travel, easily surviving up to 50-g bumps. Even more than a typical laptop, The Brick is truly transportable computing.

The system I tested had 1 megabyte of RAM (which is

continued

expandable to 8MB), a 3½-inch 1.44-MB floppy disk drive, and a 40-MB Conner Peripherals hard disk drive (100- and 200-MB drives are also available). There's also a 2400-bps modem, high-resolution (up to 1024 by 768 pixels) VGA graphics, a parallel port, a pair of serial ports, and room for a half-length add-in card (or two half-length cards if you forgo the floppy disk drive). You also get a monochrome monitor and keyboard.

Technologically, this is one of the most integrated systems I've ever seen. Packing all this big-system functionality into a tiny case wasn't easy, and Ergo uses the latest cutting-edge technology. Two packed circuit boards contain Chips & Technologies' low-power LEAP chip set and 452 VGA chip. Pack the modem chips, some RAM, and the other necessary support circuitry into the package, and it all fills every nook and cranny.

All this circuitry, of course, generates heat, even though the entire system draws only 28 watts of power. How this heat is dissipated is unique. The Brick's main processor board sits against a flat, heavy-duty plastic "blanket" filled with an inert heat-conducting liquid. This carries the heat generated by the circuits to the extruded-aluminum case, which is designed as a large heat sink. During operation, the entire case becomes lukewarm.

THE FACTS

Ergo Model 1: The Brick
$2695; with color monitor, $2995

Ergo Computing
One Intercontinental Way
Peabody, MA 01960
(508) 535-7510
Inquiry 987.

Ergo says that it will soon be offering a Sharp flat-panel VGA display and a compact keyboard. Available this fall for an additional $800, they'll make The Brick a truly powerful portable indeed. Also coming down the pike is a $249 "docking unit" for making hookup of The Brick at multiple locations easier.

Of all the surprises hidden inside The Brick, the bottom line is even more notable. In today's market, $2695 is a skimpy price for a not-at-all skimpy system (including a keyboard and monochrome VGA monitor). In a world of boring and utilitarian PCs, The Brick stands out for both its elegance and its technological sophistication.

—Stan Miastkowski

Borland Beefs Up the Programmer's Toolkit

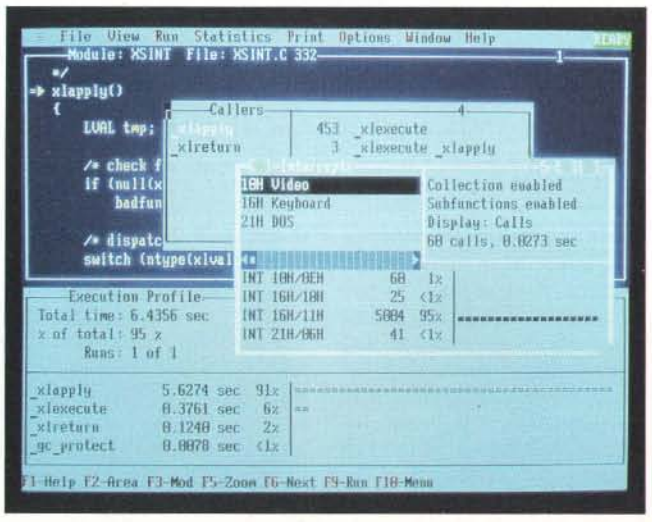
Too many programmers fly by the seat of their pants, lacking instrumentation with which to measure software performance. Turbo Profiler, star of **Turbo Debugger and Tools 2.0**, delivers the data and eliminates the guesswork. Users of Borland languages—and of other language products, since the Profiler is .MAP- and CodeView-compatible—will wonder how they ever got along without it.

THE FACTS

Turbo Debugger and Tools 2.0
$149.95

Requirements:
IBM PC or compatible with 384K bytes of RAM.

Borland International
1800 Green Hills Rd.
P.O. Box 660001
Scotts Valley, CA 95066
(408) 438-8400
Inquiry 988.



The Profiler shares much technology with an upgraded Turbo Debugger. Both sport a character-mode graphical user interface, utilize the same .EXE-embedded symbolic information, and, when running on a 386, can operate in extended memory on a virtualized real-mode DOS program.

The 386 support saved the day when I set out to test the Debugger and Profiler on the latest version of XScheme. The real-mode tools could not digest the 210K-byte large-model program, but their protected-mode counterparts worked flawlessly.

continued

Embedded systems designers have already used **CrossCode C** *in over 577 different applications.*

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From C source to final object, each tool takes you one step closer to your finished ROMable design

CrossCode C is designed specifically to help you write ROMable code for all members of the Motorola 68000 family. Four powerful tools take you from C source to object code:

1. COMPILER: To get truly ROMable code, you have to start with a truly ROMable compiler. Here are three **CrossCode C** features that you won't find in any ordinary C compiler:

- Compiler output code is split into five independent memory sections that you can assign into ROM or RAM as you please.
- You can optimize the code for your application because *you* control the sizes of data types. For example, you can optimize for speed by using two byte *ints*, or get maximum versatility by using four byte *ints*.
- You can easily write assembly language routines that call C functions and vice versa, because the compiler uses simple, well documented parameter passing conventions.

2. ASSEMBLER: CrossCode C comes with a Motorola-style assembler that has all the features that assembly language programmers require. In fact, you could write your whole application with it:

- The assembler features an advanced macro language, conditional assembly, "include" files, and an unlimited size symbol table.
- Detailed cross references show you where you've defined and referenced your symbols.
- After a link, you can actually convert your "relocatable" assembler listings into "absolute" listings that contain absolute addresses and fully linked object code.

3. LINKER: The **CrossCode C** linker is designed to handle truly huge loads. There are no limits on the number of symbols in your load or on the size of your output file. And you can always count on full 32 bit target addressability, because the linker operates comfortably in the highest ranges of the 68030's address space.

4. DOWNLOADER: CrossCode C comes with a *downloader* that puts you in touch with all EPROM programmers and emulators. It can convert your load into Motorola S-Records, Intel Hex, Tek Hex, Extended Tek Hex, and Data I/O ASCII Hex. You can also produce a binary image and convert that image into any format you might want. In all formats, bytes can be split into EPROMs for an 8, 16, or 32 bit data bus.

Why Wait

Once you start using **CrossCode C**, you may just wonder how you ever got the job done before! It's available under MS-DOS for just $1995, and it runs on all IBM PCs and compatibles (640K memory and hard disk are required). Also available under UNIX, XENIX, and VMS.

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The Debugger (but not the Profiler) can also run in protected mode on a 286. That configuration doesn't deliver the advanced in-circuit emulator–like capabilities of the 386 Debugger, but it does solve the RAM cram.

Comprehensive mouse support most visibly sets the new Debugger apart from its predecessor. But there's more power under the hood as well. The Debugger works with Turbo Pascal 5.5 objects and is "C++ ready." It can walk backward within sections of straight-line code. A macro facility helps you reproduce the sequence of events preceding a crash. Best of all, you can now debug TSR programs and device drivers.

A new Turbo Assembler comes with the kit, too. Assembly aficionados will appreciate the new multipass architecture, which optimally encodes near jumps. The new CALL statement simplifies the interface between assembly and C or Pascal. And with the .486 directive, you can deploy i486 instructions.

These enhancements are noteworthy, but the Profiler really steals the show. You begin by specifying areas that you want to watch: These can include all routines in your program, routines in a module, or even individual lines of code within a routine. You can also monitor file I/O, overlay swapping, and interrupts.

Statistics gathering can take a long time, depending on the number of areas you're watching, but at any point you can do Control-Break to view the current execution profile. The Profiler presents hot spots—the areas in which your program spends most of its time—in a scrollable bar graph and links the graph to code in source and assembly form. If you enable the callers option, you can examine the code paths leading to a hot spot.

The process isn't effortless—nor could it be. Effective analysis requires skillful modulation from coarse- to fine-grained data collection. And I can think of improvements. For example, while investigating XScheme, I found that the Profiler's interrupt-monitoring and execution-profiling subsystems aren't linked as tightly as they could be. But why quibble? Here's a tool that will help make software engineering a reality.

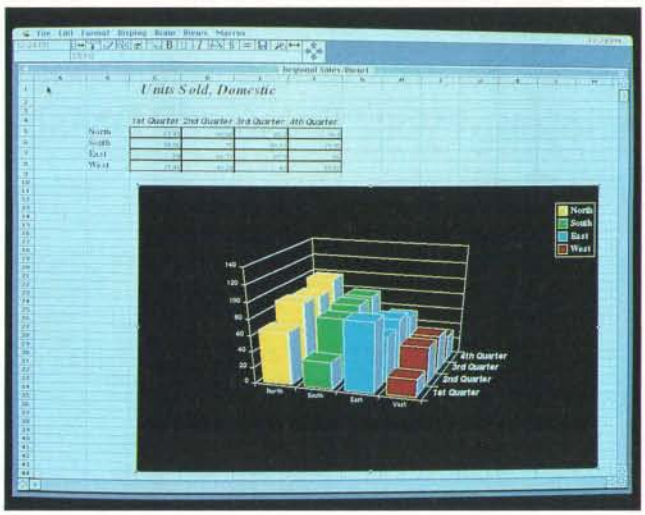
Bravo, Borland!

—Jon Udell

Full Impact 2.0 Hits a Little Bit Harder

Ashton-Tate's new Full Impact 2.0 has gone three-dimensional and added features, yet it has retained the impressive presentation qualities of the original Full Impact.

An important new feature is the ability to read and write Excel format files. Version 2.0 also has three-dimensional charting abilities, including surface plots, and you can output to color printers—moving Full Impact a step ahead as a leading Macintosh presentation spreadsheet package.



I took a look at a beta version and found the new productivity enhancements a real boon. You can assign common functions to an icon bar and perform them with just a click of the mouse. I also found it extremely simple to enter a complex set of data and start performing analysis on it. Then when I wanted to create a presentation, I could rapidly move the data around, add in text boxes and arrows, and precisely place the charts. It was a bit harder, however, to make the charts appear the way I wanted them to, once they were placed. A dialog box can be accessed to alter the appearance of the chart, and this was very useful for an overlay chart made by combining three line graphs. However, I had trouble getting a 3-D chart to turn out the way I wanted it to, although I finally succeeded.

Intelligent recalculation is an important addition, especially when considering that Full Impact can handle up to eight spreadsheets at once, each with half a million cells, even on a 1-megabyte machine.

The new feature that I liked best was an addition to the macro capability of the program. Although its macro capability has always been impressive, Ashton-Tate has now added an Excel macro translation utility, as well as making all the other new features of the program available via macros. The result is that any object on the spreadsheet (e.g., a piece of text like "click on me") can become a button that activates a macro. This makes it possible to create extremely flexible and powerful spreadsheets with Full Impact.

With version 2.0, you can use embedded calculations by customizing numerical formats. You can use this feature to convert values over a range automatically just by applying a new format to that range. You can now zoom in and out of the spreadsheet so that you can see up to 64 pages of the spreadsheet presentation at once. At any level, you can edit and move items so you can see—on-screen—the overall look of a presentation before printing.

Full Impact 2.0 is considerably improved, and it faces a more open spreadsheet market than previously. However, all the Mac spreadsheets are considerably more powerful than they used to be, and Full Impact 2.0 will undoubtedly face stronger competition in the future. ■

—Owen Linderholm

THE FACTS

Full Impact 2.0
$295

Requirements:
Mac Plus, SE, or II with 1 MB of RAM; a hard disk drive is recommended.

Ashton-Tate
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Torrance, CA 90502
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Inquiry 990.

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Windows 3.0 carries DOS into the 1990s

Three's the One

■ Jon Udell

Users of DOS PCs rejoice! Windows 3.0 will breathe new life into your machine. Microsoft has bundled a graphical environment, a suite of desktop applications, a DOS program switcher, a Windows multitasking executive, a V86 multitasker, and a virtual memory manager into a single package.

Windows has long aspired to change the face of DOS computing—not just for Excel or PageMaker addicts, but for the rest of us. A year ago, that transformation seemed unlikely. Today it appears inevitable. Windows 3.0 finally consummates the Windows/DOS marriage. That is good news for the 386 crowd, and it's great news for the silent majority: 286 owners who've lately been made to feel like they have bought an Edsel.

Windows 3.0 runs in three modes: real, standard, and 386 enhanced. When you type `win` at the DOS command line, Windows scopes out the local hardware configuration and starts up in the appropriate mode: real mode on a 640K-byte XT or AT, standard mode on an AT with at least 256K bytes of extended memory or a 386 with up to 1 megabyte of extended memory, and 386 enhanced mode on a 386 with more than 1 MB of extended memory. All modes share the same radically improved graphical user interface (GUI) and enhanced suite of Windows desktop applications. Standard mode adds the ability to run Windows 3.0 applications in 286 protected mode—that is, with direct access to up to 16 MB of extended memory. The 386 enhanced mode adds more: preemptive multitasking of DOS programs running in V86-based virtual machines, and demand-paged virtual memory.

You can override the default start-up behavior. For example, you can type `win /r` to start Windows 3.0 in real mode on a 286 or 386. And to run an existing Windows/286 or Windows/386 application, that's just what you'll have to do. Windows 3.0 is fundamentally a DOS extender. The DOS-extended programs that it can execute—Windows 3.0 applications—must abide by the same laws that govern all protected-mode applications. That means, among other things, that a program can't write to a code segment, perform segment arithmetic, compare segment addresses, or load a segment register with a value other than one provided by the operating system.

Most existing Windows applications—and virtually all the major ones—will require a tune-up in order to comply with Windows 3.0. But the trauma won't be as severe as you might think. In general, even ordinary DOS applications port readily to DOS extenders. Windows programs, written to a far stricter application programming interface (API) that was designed with protected mode in mind, find the transition even easier. Also, Windows developers have been working with version 3.0 for months; many have already completed their ports. At least one shipping application, Word for Windows, won't even require an upgrade—it's already 3.0-compatible.

Although Windows 3.0 costs $150, Microsoft will upgrade existing Windows/286, Windows/386, and Windows run-time users for $50 within 90 days of its release date. Application upgrade policies should be similarly reasonable in most cases. Through the end of August, users can call (800) 323-3577 to inquire about and order Windows 3.0–compatible products.

The New Windows Desktop

By design, the Windows desktop closely resembles that of OS/2 1.2. And yes, that means that like Presentation Manager, Motif, and NextStep, Windows offers what seems to have become the sine qua non of the modern GUI: buttons shaded to create a three-dimensional effect. But look more closely at the photo at right and you'll discover a far more significant enhancement. Both PM and Windows support child windows that run as windows or as icons within the boundaries of a parent window, sharing its menu bar. You can see two examples of this behavior in the photo. Both the File Manager (similar to OS/2 1.2's File Manager) and the Program Manager (Windows 3.0's primary shell) contain child windows in active and iconic states.

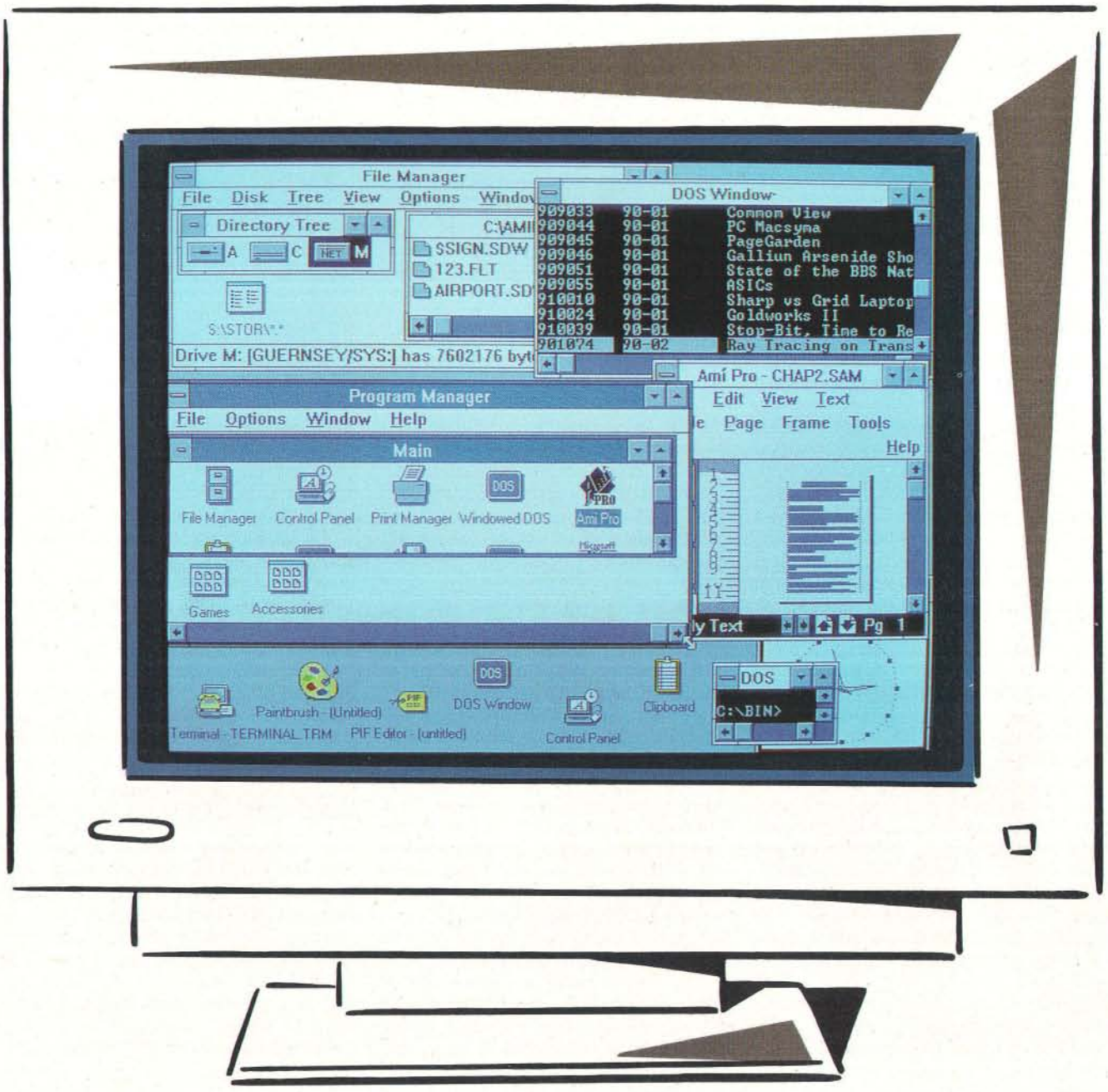
I've yet to see another Windows 3.0 application that exploits this technique (which IBM's Common User Access style guide calls the *multiple document interface*, or MDI) as fully as the File Manager and the Program Manager do. But the new Software Development Kit (SDK) includes an MDI code skeleton, and I hope many applications will adopt this style. Other GUIs' window systems pale by comparison; they limit you to a single top-level desktop. Windows 3.0 (like OS/2 1.2) supports a hierarchy of desktops. Each records the arrangement of windows and icons running in support of a task. You can collapse the entire aggregation into a top-level icon, thus sweeping away a lot of visual clutter. And you can recall the task and all its associated context with a single keystroke.

continued

COVER STORY

Running Windows 3.0 on a 386, you can multitask windowed DOS programs along with Windows protected-mode applications.

Even on a 286, Windows 3.0 applications use extended memory. With its powerful new shell, protected-mode capability, color palette manager, and network awareness, Windows 3.0 gives DOS-based computing a powerful shot in the arm.



SCREEN PHOTOGRAPHY: PAUL AVIS/ILLUSTRATION: CATHARINE BENNETT © 1990

Here is a practical way to manage a dozen tasks, each with one or more windows—even on a standard VGA screen.

You interact with Windows and DOS by way of five key desktop applications: File Manager, Program Manager, Task List, Control Panel, and Print Manager. File Manager, like its OS/2 counterpart, views disk drives the way an outline processor does. Its primary child window presents a directory tree; you single-click on nodes to show or hide their descendants. Double-click on a directory node, and File Manager opens a new child window that lists the files in that directory. You can opt for an iconic or a textual display, sorted in a variety of ways. As with the old Windows MS-DOS executive, you can select and launch DOS or Windows applications directly or indirectly by way of documents associated with applications. New conveniences include the ability to copy and move files and subtrees using the mouse, the ability to invoke an application by "dragging and dropping" a compatible document onto its icon, and the ability to search for files.

File and Program Managers

If you inspect the photo carefully, you'll see that the File Manager knows that the highlighted drive icon represents a network drive. (The same holds true for CD-ROM drives.) But that is just a glimpse of Windows 3.0's network awareness. It goes much further. The product provides extensive hooks for a variety of networks, including MS-Net, LAN Manager, NetWare, and Vines. When you install Windows 3.0 in the presence of one of these networks, it loads a corresponding driver. (NetWare users take note: You'll also need to update your network shell components by way of NetWire or the Novell hotline.)

The network driver provides many conveniences. From the File Manager, for example, you can execute `Connect Net Drive`. It provides a graphical interface to MS-Net's `net use`, NetWare's `map`, or whatever command your network uses for this purpose. With `Browse`, you can look through the list of available servers and mounted volumes for the drive to which you want to connect. The specific form that this dialogue takes will, again, vary according to your specific network.

The File Manager, like the Macintosh Finder, is fundamentally a disk organizer. The Program Manager works quite differently; it's a task organizer. If you prefer the disk-oriented approach, you can make File Manager the primary shell; just open WIN.INI and specify `shell=winfile.exe`. But Windows 3.0 defaults to the Program Manager, and for good reason. Its elements are *groups* and *program items*. Groups are child windows that contain iconic program items that, in turn, refer to applications and optionally to associated documents. But when you create groups, add program items, and copy or move program items between groups, you're not manipulating the applications or documents themselves; you're manipulating pointers to them. The added flexibility takes some getting used to, but it's extremely useful.

You link program items to applications by way of the Program Manager's Properties dialogue. Here you supply an application's command line: an .EXE (Windows- or DOS-executable), .PIF (a Program Information File that tells Windows how to allocate resources for a DOS program), .COM, or .BAT file, along with command-line arguments if required. Unless you declined the offer, the Windows setup program will have scanned your local (and network) drives and created program items for all your Windows applications and for the DOS applications for which Windows provides predefined .PIF files.

Like File Manager, Program Manager can tile or cascade its active child windows and arrange those that are running as icons. You can select and activate any group window or group window icon from a list. And you can minimize any group window, or minimize the Program Manager itself.

Tasks, Controls, and Printing

Task List pops up when you double-click on the desktop, press Control-Escape, or choose Switch To from any window's control menu. It can tile or cascade top-level windows, arrange top-level icons, enumerate tasks, switch among tasks, or kill a task. The several mouse and keyboard procedures for starting the Task List typify Windows 3.0. Like its predecessors, and despite its greater complexity, Windows 3.0 operates quite nicely under keyboard control. No one will want to use the product without a mouse, but power users will appreciate the dozens of keyboard shortcuts.

The Control Panel provides a suite of configuration tools. Some of the tasks you can perform here include resetting the desktop colors, installing or removing printer and screen fonts, attaching to an alternate network server, configuring communications ports, installing and configuring printers, and specifying multitasking settings for 386 enhanced mode. In the Colors dialogue, you can switch to an alternate desktop color scheme or invent your own. The Ports dialogue repairs a long-standing deficiency: At last, Windows itself supports XON/XOFF flow control.

The Printers dialogue illustrates another facet of Windows' new network awareness. Once you've specified a port (e.g., LPT1) and a printer (e.g., HP LaserJet), you can browse network print queues and connect the port to a queue that supports your selected printer. Windows intelligently offers to bypass the local spooler and print directly to the network queue. With earlier versions of Windows, you had to disable spooling entirely in order to use network queues. Now you can configure spooling on a per-printer basis.

The Print Manager handles both local and network queues. Even when you bypass the Windows spooler and print straight to a network queue, you can use the Print Manager to monitor the job's progress. Local queues display only jobs printed from Windows applications, but network queues—thanks to the intervention of the network driver—list all your print jobs. By default, a network queue won't list other users' jobs, but you can ask to see the complete list, and (again, depending on the specific capabilities of your network and its Windows driver) you can even browse network queues to which you're not connected.

The desktop applications offer extensive on-line help. Like OS/2 1.2, Windows 3.0 documents itself hypertextually and, in its SDK, provides tools and protocols that enable applications to follow suit. The Windows 3.0 applications I've seen take advantage of the help engine, which lends a nice consistency to the environment. I particularly like the way the help system enables users to annotate on-line documentation.

Wide-Open Spaces

As I write these words, I'm running Windows 3.0 in 386 enhanced mode on a 20-MHz 386 Gateway 2000 with 4 MB of memory. The Task List repors that I'm running FoxBase (in a virtual DOS machine), Epsilon (in another virtual DOS machine), five Windows 3.0 desktop applications (File Manager, Program Manager, Paintbrush, Terminal, and Notepad), and three additional Windows 3.0 applications (Microsoft's Excel, Sam-

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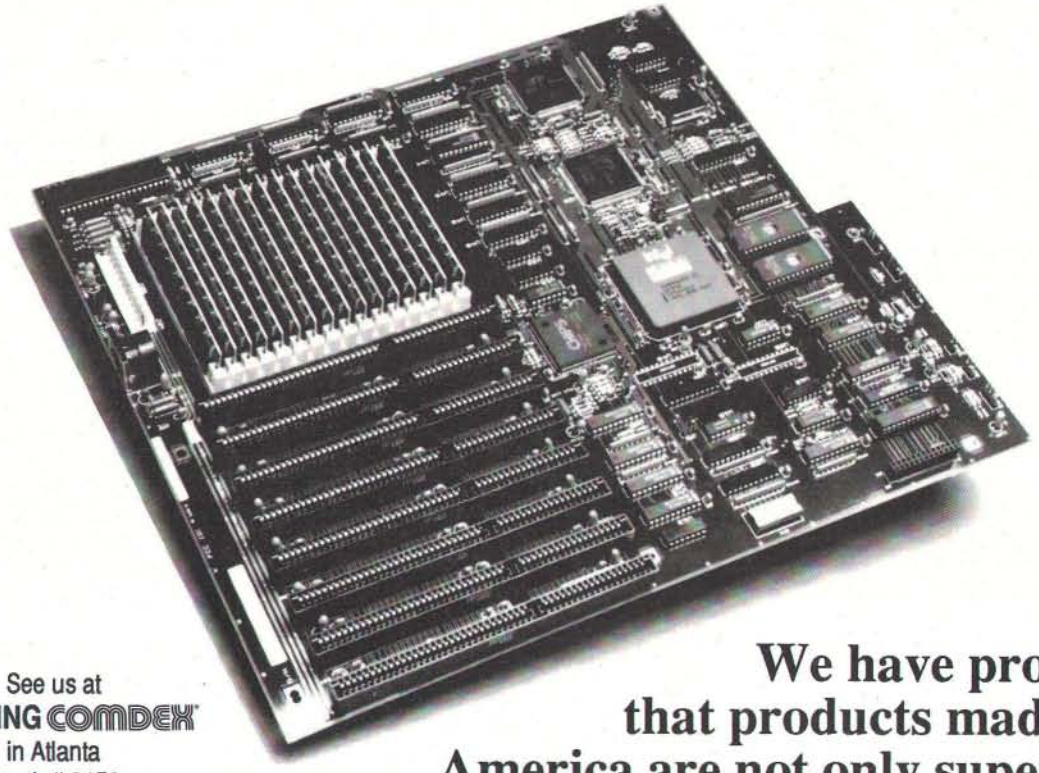

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na's Amí Professional, and Asymetrix's HyperCard-like ToolBook). CHKDSK, which I ran in each of the two DOS sessions, reported 477K bytes of free DOS memory—scarcely less than the 486K bytes available to DOS after I booted and loaded my network drivers but before I launched Windows. Meanwhile, the Program Manager reports more than 10 MB of free Windows memory. How can this be? DOS multitasking based on the V86 mode of the 386 processor is nothing new. But add protected-mode Windows applications running in extended memory with access to virtual memory, and you're really pushing the envelope.

It's a different story on a 286, but not too different. On the DOS side, you substitute program switching for DOS multitasking and give up hardware protection, and you get somewhat less DOS memory. Running Windows in standard mode on a 1-MB Compaq Deskpro 286e, I found that a secondary DOS session saw 44K bytes less free memory than did the boot session. On the Windows side, you give up virtual memory. Yet although standard mode appears limited when you compare it to 386 enhanced mode, it legitimizes the 286 in a way that no other software product ever has. You can still run multiple DOS applications reasonably, side by side with Windows applications. And those Windows applications, using as much extended memory as you care to install, will really be able to stretch their legs.

DOS extenders come in two flavors. The 286 extenders, such as Rational Systems' DOS/16M, break through the 640K-byte memory barrier and enable programs to run in extended memory on a 286 or a 386. But they still form addresses with 16-bit offsets, so they can't manipulate data objects larger than 64K bytes. The 386 extenders, such as Phar Lap's 386|DOS-Extender, also break the 64K-byte segment barrier. They run only on a 386, but they can form addresses with 32-bit offsets and thus present a "flat" 4-gigabyte address space to applications. Windows 3.0 is a 286 extender. It runs programs in extended memory, but even on a 386 those programs don't see the flat address space that is characteristic of 386|DOS-Extender, Unix, or OS/2 2.0. To manipulate very large bit maps, for example, Windows 3.0 programs must still resort to the huge memory model that tiles segments.

Although Windows 3.0 offers 386-specific features—V86 multitasking and demand-paged virtual memory—the 286 is its true target platform. While the 64K-byte segment limit may be inconvenient, the 640K-byte limit has been Windows' ball and chain. That's gone now, and both 286 and 386 users will reap the benefits. Existing Windows applications, once converted, will enjoy what amounts to a free lunch. Developers who couldn't contemplate working in real-mode Windows will think much harder about developing for Windows 3.0.

Living with Windows 3.0

Like many people, I've always thought of Windows as an application launcher, not a working environment. I'm no fan of DOS shells; the ones I've tried feel like straitjackets. But the notion of a dual environment in which DOS and Windows applications coexist was always alluring. So with each successive version of Windows, I've put the `win` command into my AUTOEXEC.BAT file, just to see how long it could survive there. Earlier versions of Windows never lasted more than a day. This one's a keeper. For the first time, the Windows/DOS coexistence entails relatively few compromises. DOS sessions see more memory than in previous versions of Windows—in standard mode as well as in 386 enhanced mode. Even more important to me is that access to network services removes what had been a major obstacle to sustained use of Windows. For example, Windows used to simply reject a message sent over a network. Now it fields the message and presents it in a Windows alert box. The only major sacrifice—and this will be a problem for many users—is that you can't use protected-mode memory managers like QEMM and 386Max with Windows 3.0's standard or 386 enhanced modes.

Some of the things I've learned about Windows aren't new to version 3.0. Like Windows/386, 3.0 supports cut-and-paste operations between windowed DOS programs and Windows applications. One evening, while connected to BIX by way of the Terminal accessory (see below), I used the BIX `search` command to generate a list of messages. The next step was to reformat the message numbers as a comma-separated list and feed that list to the `file` command. I copied the `search` output from Terminal's buffer to the clipboard, pasted it into my DOS text editor, built a macro to reformat the numbers, and pasted the result back into Terminal.

What's new—to me, anyway—isn't the cut-and-paste feature itself, but the opportunity to use it. You'd never load Windows just to cut and paste between applications. And you'd never load it just to run one of its accessories: Notepad, Write, Terminal, Paintbrush, Calendar, Calculator, or Cardfile. But if you establish the Windows desktop as your working environment—and 3.0 makes that eminently practical—you'll find that it has a lot to offer.

I've always used Notepad for quick text-editing tasks in the Windows environment, but now I find Write perfectly adequate for memos and correspondence. Paintbrush, derived from ZSoft's PC Paintbrush, operates in color and improves on the old Windows Paint program in a number of other ways. Since it supports both .PCX and .BMP (Windows bit-map) formats, it serves as a gateway between DOS- and Windows-based image-processing programs.

Terminal now handles binary file transfers; while it's not a full-featured telecommunications program (it has no scripting capability), it's nevertheless quite useful. The new Calculator adds a scientific mode. It supports trigonometric and statistical functions and can operate in binary, octal, and hexadecimal number systems. Even Cardfile—a sort of Rolodex that can store scraps of text and black-and-white images—turns out to be surprisingly handy. Like the Mac's Scrapbook, Cardfile holds a persistent collection of clipboard items.

Raster Rainbows

Right out of the box and running on a standard VGA display, Windows 3.0 looks more colorful than its predecessors. Tasteful use of color has much to do with that impression. Although you can change the desktop's color scheme, you will be hard pressed to come up with a better one. But there are also more colors to work with. Earlier versions of Windows could use just eight of the 16 pure colors available in the VGA 640- by 480-pixel by 16-color mode; Windows 3.0 uses them all.

Behind the scenes, there's a whole new color architecture waiting to be exploited. The new Windows API defines 1-, 4-, 8-, and 24-plane device-independent bit maps. These formats, which are compatible with OS/2 color bit maps, extend the device independence that Windows applications enjoy to the realm of color imagery. Hardware color capability, not Windows itself, becomes the limiting factor.

To support color-intensive Windows applications, the new API also defines a set of palette management functions. These functions facilitate orderly arbitration among applications competing for

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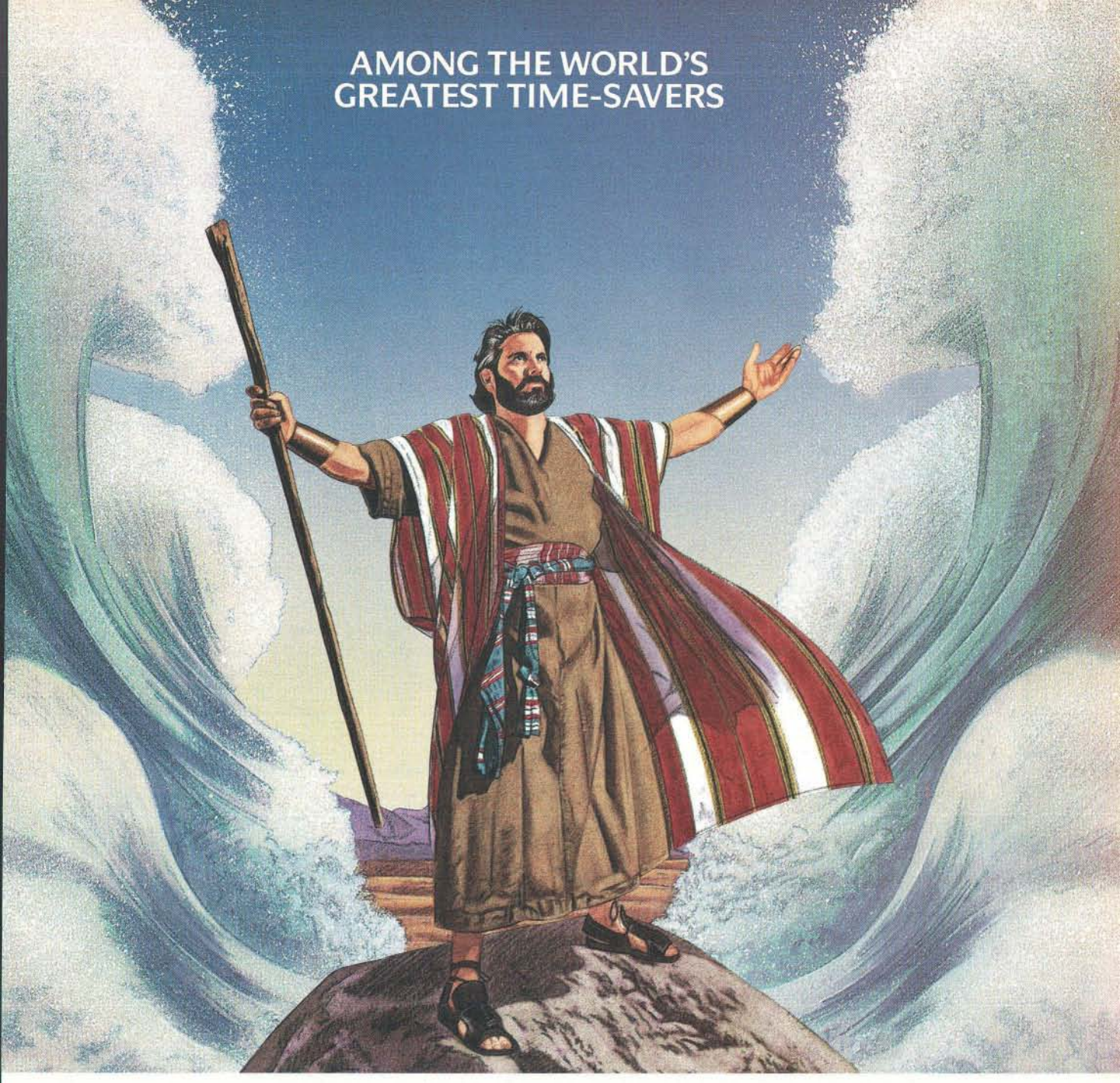

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the use of a limited supply of colors. An application can define a list of colors that it requires, in order of importance. When it runs in the foreground, the application gets first choice of the colors available in the system palette. Background applications contend for the remaining colors; they receive consideration in reverse order of activation. If the system palette runs out of free colors, Windows maps some or all of their requests to the closest colors already in use, taking each application's specified color priorities into account.

Windows reserves a pool of 20 static colors; that's the default palette used for window titles, menu bars, and other standard desktop elements. That means most applications won't need to concern themselves with the intricacies of palette arbitration. On a 16-color VGA display, it's not even an issue. But as Windows 3.0 drivers designed for more capable video boards arrive, and as Windows applications begin to exploit 256 and more colors, the palette manager will come into its own. Video Seven and 8514/A drivers are included with Windows 3.0, by the way. But most users of better-than-VGA display hardware will have to wait a while to find out what Windows 3.0 can really do with color.

Running DOS Applications

When you run your DOS programs under Windows 3.0, the standard and 386 enhanced modes correspond closely to Windows/286 and Windows/386. In standard mode, DOS programs run full-screen and uninterrupted. You can have one or more DOS sessions; each swaps to disk when you switch away from it. Standard mode improves on Windows/286 in several ways. There's more memory for DOS programs because Microsoft has dropped a little-used feature of Windows/286—the ability to window well-behaved applications. The Program Manager and Task List make it easier to find and switch to your DOS applications. Windows 3.0's 386 enhanced mode, like Windows/386, creates a powerful hybrid environment. The Windows session, within which Windows applications multitask cooperatively, itself multitasks preemptively with one or more virtual DOS machines. A DOS program can run full-screen or in a window; Alt-Enter toggles between the two display modes. You can run textual and (with restrictions) graphical displays in windows.

Each virtual machine inherits and can customize the boot DOS session. Since the original TSR memory hit propagates to all virtual machines, it's best to start lean (e.g., with just network drivers) and then load extras on a per-session basis. There is no AUTOEXEC.BAT file for virtual machines, but you can use .PIF files in conjunction with .BAT files to tailor your DOS sessions for specific purposes.

The 386 enhanced mode outclasses Windows/386 in several respects. Virtual memory enables you to run more DOS sessions. And you've got greater control over how those sessions multitask. A Windows/386 .PIF file offers three options. *Foreground* means run only in the foreground while background tasks run concurrently. *Background* means run in the foreground or the background while background tasks run concurrently. *Exclusive* means run only in the foreground and halt all other tasks. Windows 3.0 preserves and extends these options. You can adjust each DOS task's (or Windows' own) foreground and background time slice. A new form of the exclusive mode gives a DOS task all the cycles it wants while active, but it enables Windows to switch away from it when idle. When there's an interrupt pending to a virtual machine, Windows temporarily boosts its priority to maintain crisp keyboard response. In special cases, you can speed up a DOS program by locking its EMS, Extended Memory Specification, or conventional memory.

Virtual machines require virtual devices. Windows provides drivers for the basic ones—disk, video, and keyboard—but you might run into a problem with a less common device. For example, my floppy disk drive controller–based tape drive won't work with Windows 3.0 in 386 enhanced mode, so I can't run tape backups in the background.

What about DOS-extended programs? For now you have to drop down to standard mode to run 286 DOS-extended programs like Lotus 1-2-3 release 3.0, and to real mode to run 386 DOS-extended programs like Interleaf Publisher. But there's hope of better things to come. DOS-extender vendors are working hard to comply with the new DOS Protected Mode Interface, which will enable Windows 3.0 (or any other DPMI server) to multitask protected-mode applications. It sounds even scarier than the Virtual Control Program Interface, but the current popularity of DOS extenders and the likely success of Windows 3.0 will probably make DPMI a reality.

The OS/2 Killer?

Has Microsoft, which also sells OS/2, committed corporate fratricide? Yes and no. Windows 3.0 addresses, and satisfies, many pressing needs. Rarely does an operating-system upgrade render existing hardware so much more useful. Windows 3.0 will delight longtime Windows fans and win many new converts. Developers are flocking to the platform and, in some cases, shifting their focus from OS/2's PM to Windows. The Windows momentum that has been building is about to become a tidal wave.

But scratch the elegantly polished surface and you'll still find creaky old DOS. OS/2 really is much better. Its multithreaded architecture, 32-bit programming model, High Performance File System, and rich Graphics Programming Interface should eventually earn it the respect it deserves.

Windows 3.0 could be the best thing that ever happened to OS/2. It's ideally positioned to draw huge numbers of DOS users into the realm of GUI-based multitasking. Many will remain happily within the Windows fold. As client/server applications evolve, the Windows 3.0 client workstation—communicating with servers running OS/2 or its competitors—seems destined to become an important industry standard. But power users who yearn for a better foundation under the graphical desktop will find the move from Windows to OS/2 natural.

In the meantime, on both technical and strategic grounds, Windows 3.0 succeeds brilliantly. After years of twists and turns, Microsoft has finally nailed this product. Try it. You'll like it. ■

Editor's note: *BYTE's Windows 3.0 coverage continues next month with hands-on descriptions of specific applications that have been redesigned to work with the new graphical environment. The selection will include applications for word processing, databases, spreadsheets, and developers' tools, among others. In the months beyond, look for articles that tell the Windows 3.0 story in still greater depth and breadth.*

Jon Udell is a BYTE senior editor at large. You can contact him on BIX as "judell."

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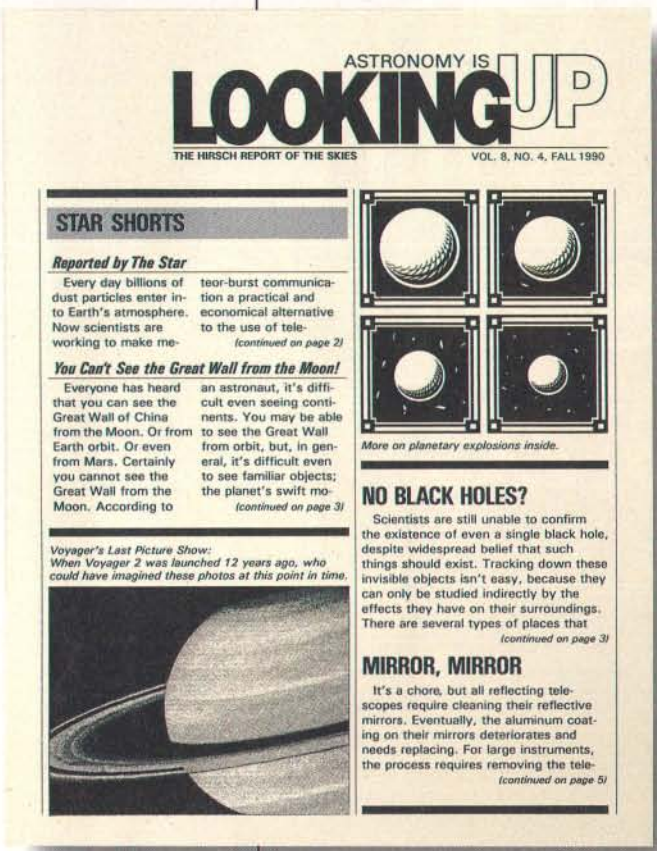

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STAR SHORTS

Reported by The Star

Every day billions of dust particles enter into Earth's atmosphere. Now scientists are working to make meteor-burst communication a practical and economical alternative to the use of tele-

(continued on page 2)

You Can't See the Great Wall from the Moon!

Everyone has heard that you can see the Great Wall of China from the Moon. Or from Earth orbit. Or even from Mars. Certainly you cannot see the Great Wall from the Moon. According to an astronaut, it's difficult even seeing continents. You may be able to see the Great Wall from orbit, but, in general, it's difficult even to see familiar objects; the planet's swift mo-

(continued on page 3)

Voyager's Last Picture Show: When Voyager 2 was launched 12 years ago, who could have imagined these photos at this point in time.

More on planetary explosions inside.

NO BLACK HOLES?

Scientists are still unable to confirm the existence of even a single black hole, despite widespread belief that such things should exist. Tracking down these invisible objects isn't easy, because they can only be studied indirectly by the effects they have on their surroundings. There are several types of places that

(continued on page 3)

MIRROR, MIRROR

It's a chore, but all reflecting telescopes require cleaning their reflective mirrors. Eventually, the aluminum coating on their mirrors deteriorates and needs replacing. For large instruments, the process requires removing the tele-

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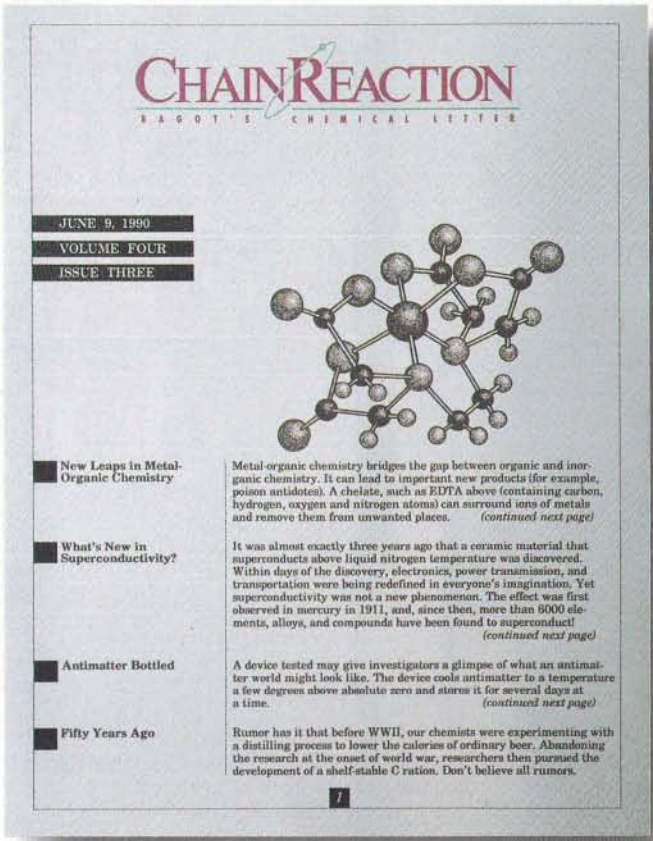

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(continued next page)

What's New in Superconductivity?

It was almost exactly three years ago that a ceramic material that superconducts above liquid nitrogen temperature was discovered. Within days of the discovery, electronics, power transmission, and transportation were being redefined in everyone's imagination. Yet superconductivity was not a new phenomenon. The effect was first observed in mercury in 1911, and, since then, more than 6000 elements, alloys, and compounds have been found to superconduct!

(continued next page)

Antimatter Bottled

A device tested may give investigators a glimpse of what an antimatter world might look like. The device cools antimatter to a temperature a few degrees above absolute zero and stores it for several days at a time.

(continued next page)

Fifty Years Ago

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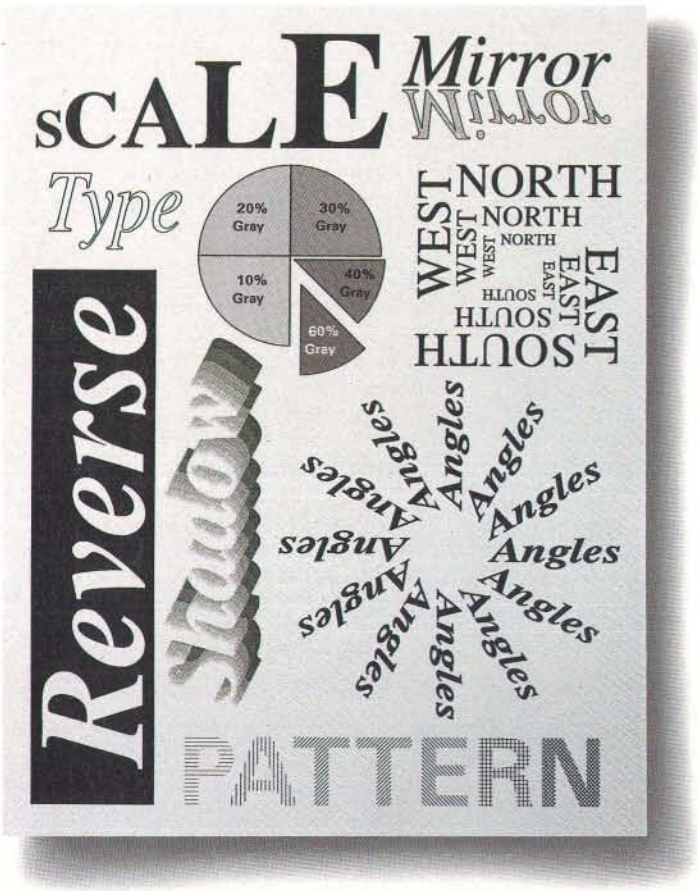

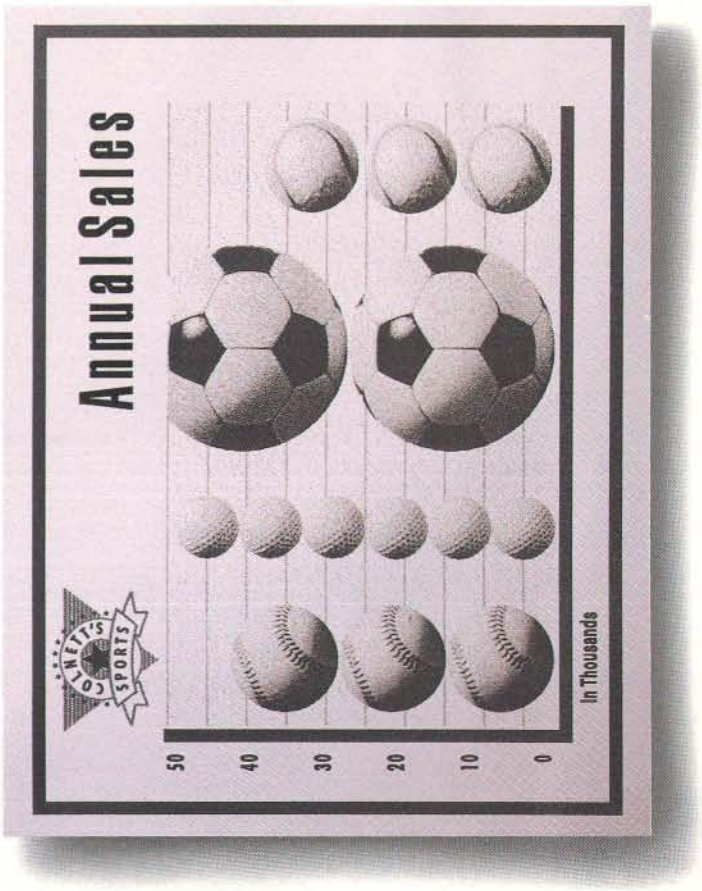

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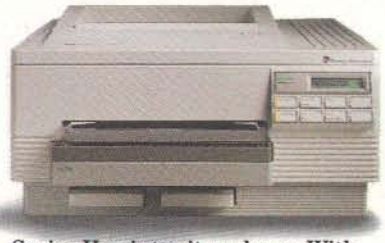

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Cheetah's Golden Performer

Rob Mitchell and Rick Grehan

The Cheetah 433 AT Gold isn't the world's first 33-MHz 486 PC, but it's certainly one of the fastest. The 433 leaps past today's pack of 25-MHz 486 machines to provide one of the fastest performances of any PC that BYTE has tested to date (see the table).

But a 33-MHz CPU isn't the 433's only unique feature. The machine is the first we've seen that uses 35-nanosecond DRAM chips—the fastest available—as system memory. The company says this eliminates the need for an external CPU cache. The 433 AT Gold also uses *hot cycles*, a technique that Cheetah says doubles the data transfer rate between the CPU and SCSI hard disk drive controller over the 433's standard 8-MHz AT bus, effectively equaling the performance of the Extended Industry Standard Architecture and Micro Channel buses.

Cheetah built the 433 AT Gold around the same motherboard that's in its 25-MHz 486 machine (see "Psst! Wanna Buy an 80486 Cheap?," November 1989 BYTE). The 433's CPU (a 25-MHz chip screened to run at 33 MHz in the prototype we saw) and supporting circuitry sit on a separate board that plugs into a proprietary backplane slot; a custom-designed memory board rides piggyback on the CPU board and accepts up to 16 megabytes of 35-ns DRAM chips that are mounted in 1-MB single in-line memory modules (see photo 1). The board's memory-control logic uses the i486's burst mode to achieve near-zero-wait-state operation on a cache miss.

Hot Cycles

The 433's high-performance storage subsystem includes a 323-MB Siemens MegaFile hard disk drive with Perceptive Solutions' Hyperstore 1600 caching SCSI controller board. The latter comes with a 4-MB cache of 20-ns static RAM. But having a high-performance processor and a hard disk drive subsystem doesn't do you much good if you have to communicate over a slow AT bus.

Cheetah engineers have added two enhancements to make the i486's life with an 8-MHz AT bus easier. First, a bus cycle controller sits between the i486 and the I/O bus (see the figure). The path be-

Fast 35-ns DRAM eliminates the need for a CPU cache

The Cheetah 433 AT Gold is the first microcomputer to use 35-ns DRAM chips.

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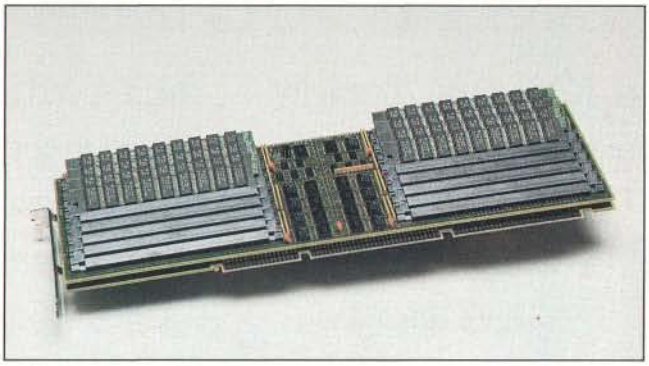

Photo 1: *The Cheetah 433 AT Gold memory board rides piggyback on the CPU board and holds up to 16 MB of 35-ns SIMM-mounted DRAM chips.*

tween the processor and controller is 32 bits wide, but on the bus side, the controller talks along the narrower and slower AT bus I/O channel. The net result: Any adapter card on the I/O bus appears to the i486 as an ideal 32-bit peripheral. When the CPU issues a write to the AT bus, it can write a full 32 bits at full speed to the bus cycle controller. The controller handles slicing the data into 16- or 8-bit chunks and moving it out along the 8-MHz bus.

In a sense, the bus cycle controller lies to the CPU, telling it that the write to the AT bus has completed when it's still in progress. But since the CPU communicates to memory along a separate route from the I/O bus controller, the i486 can converse with memory while past I/O bus write operations are still finishing.

The second enhancement is hot cycles. Essentially, the technique boils down to this: An 8-MHz AT bus cycle is about 375 ns long and is divided into several phases. The phase during which data passes along the bus lasts for about 250 ns. From the perspective of the hard disk drive controller's 20-ns memory, this is a long time. So the Cheetah system recognizes hard disk drive controller accesses and squeezes two data transfers into the time that other adapter cards would ordinarily allow only one. The bus signals that take place before and after this double transfer look the same as an ordinary transfer, so other peripherals on the bus can correctly decode the address signals and ignore the double transfer.

The 433 AT Gold video subsystem doesn't benefit from hot cycles, but it's no slouch. It consists of a prototype 16-bit Micro-Labs Ultimate VGA board with 1 MB of video RAM and supports up to 256 simultaneous colors on a 1024-by 768-pixel display. Our test machine included a Leading Technology multisync VGA monitor.

COMPANY INFORMATION

Cheetah International, Inc.
1003 West Cotton St.
Longview, TX 75604
(214) 757-3001
Inquiry 885.

BENCHMARK PERFORMANCE

The Cheetah 433 AT Gold is, overall, the fastest PC BYTE has tested to date. All the benchmark indexes given here, however, were achieved on prototype units. Final benchmark scores might vary (N/A=not applicable).

Machine	CPU	FPU	Disk	Video
Cheetah 433 AT Gold	**9.06**	**37.06**	**12.67**	**4.25**
ALR PowerVEISA 486/33	9.69	37.03	3.48	4.02
AST Premium 486/33	8.21	37.10	N/A	3.40
Cheetah 425 AT Gold	6.94	28.36	22.70	3.20

Note: The AST Premium 486/33 was unable to complete BYTE's disk benchmark suite.

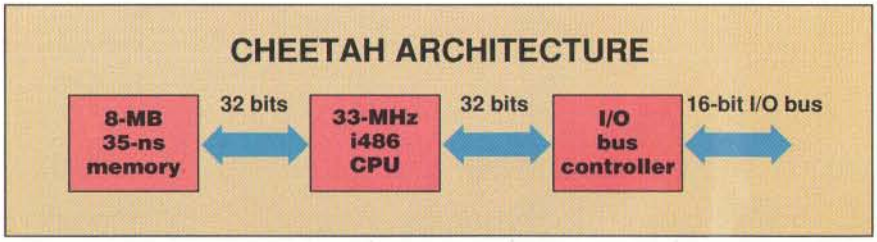

Figure 1: *The Cheetah 433 AT Gold architecture allows 32-bit writes to the I/O controller. The controller then sends the message over the slower AT bus, freeing CPU cycles for memory accesses.*

Growth Factors

Inside the system's cavernous tower case are eight half-height drive bays and eight expansion slots. High-capacity 5¼- and 3½-inch floppy disk drives occupy two bays; the SCSI and video controllers take up two 16-bit slots, leaving five 16-bit slots and one 8-bit slot available. The 433 AT Gold's two serial and two parallel ports sit on the motherboard. The 450-watt power supply should accommodate extra drives and add-in boards.

Cheetah hadn't released availability or final pricing for the 433 AT Gold at press time, but it expects our base test system with 8 MB of RAM to come in at just under $10,000. A big factor is the cost of memory. At press time, Hitachi was the only supplier of 35-ns DRAM chips, and pricing for 1-megabit chips ran around $19 in quantity—more than twice the street price of 70-ns 1-Mb DRAM chips. Many system vendors will wait for a second source before using the new chips. But prices are already dropping. Hitachi predicts prices of $12 in quantity by the fourth quarter of this year. ■

Rob Mitchell is a BYTE technical editor. Rick Grehan is the technical director for the BYTE Lab. You can reach them on BIX as "rob_mitchell" and "rick_g," respectively.

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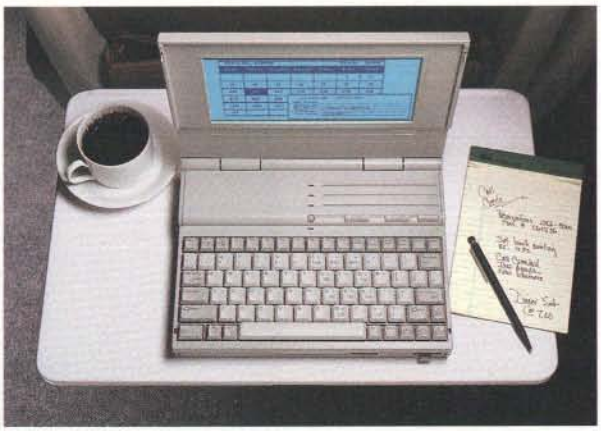

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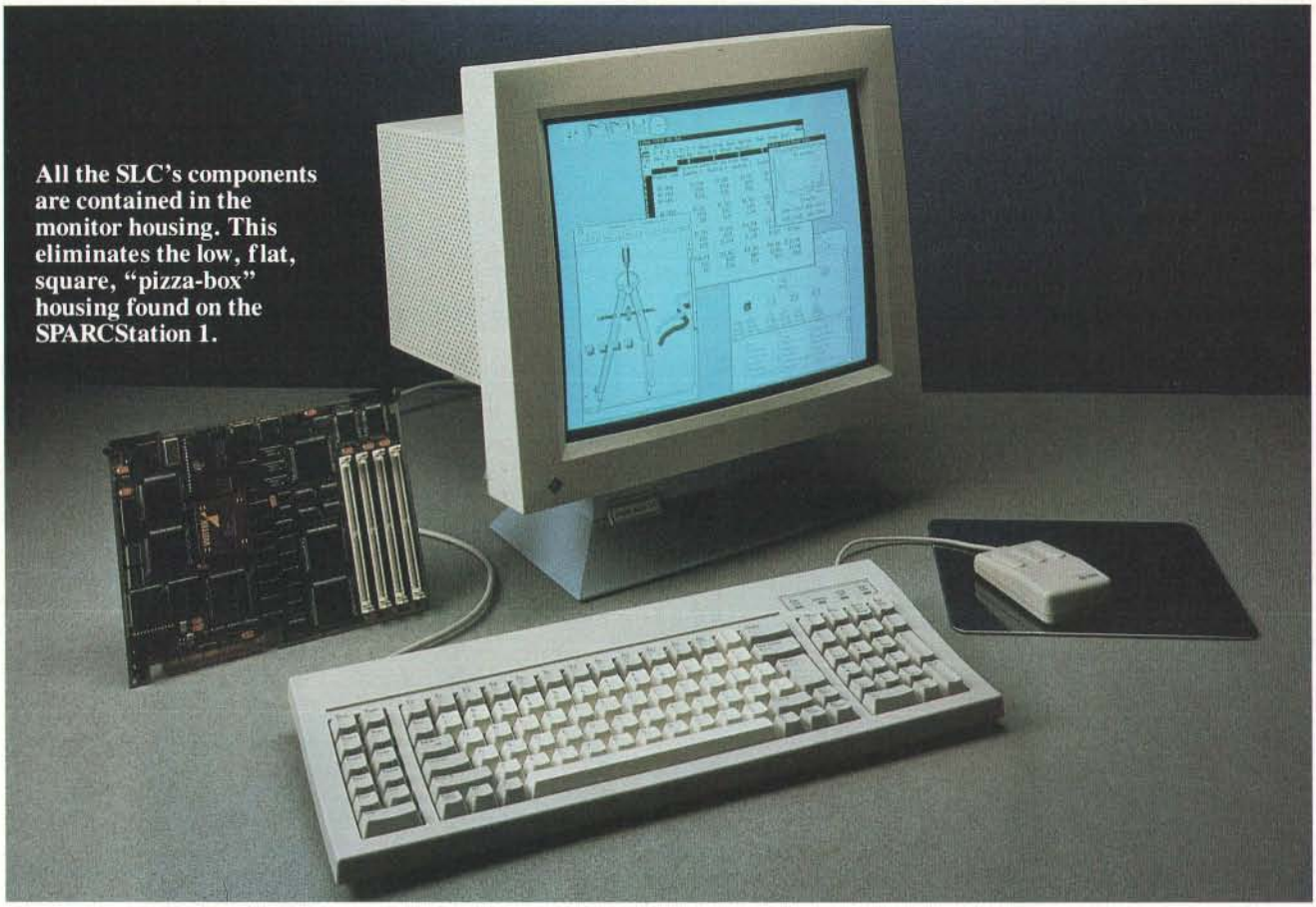

All the SLC's components are contained in the monitor housing. This eliminates the low, flat, square, "pizza-box" housing found on the SPARCStation 1.

Sun's Low-Cost RISC

■ Nick Baran

Sun Microsystems has taken another big step down the price/performance curve with the introduction of a low-cost diskless version of its RISC-based SPARCStation. With a retail price of less than $5000, the new SPARCStation SLC is quite a bargain for an office running a network of SPARCStations. This price includes not only a powerful SPARC processor rated at 12 million instructions per second (MIPS), but also 8 megabytes of memory, an Ethernet connector, and a high-resolution 17-inch monochrome display.

From a distance, in fact, you might think that the display is the *only* thing the system includes. Unlike the SPARCStation 1, there is no system unit or "pizza box" (as the appearance of the system unit on the SPARCStation 1 suggested). The entire system is packaged within the monitor cabinet. An 80-watt power supply, an audio speaker, the system board with RAM and an integrated frame buffer, and a monochrome monitor all fit neatly into a single package (see photo).

The 7½- by 9-inch system board is a shrunk-down version of the board used in the SPARCStation 1 (see "Two Powerful Systems from Sun," May 1989 BYTE). The major difference is that the SPARCStation SLC board does not include the high-speed S-Bus and its three expansion slots, nor does it have a floppy disk drive controller. The SLC board does have one SCSI and one serial port (the serial port can operate two serial devices simultaneously using a Y-connector cable), an Ethernet port, and the same audio and keyboard/mouse ports as the SPARCStation 1.

The board fits vertically into the rear of the monitor housing and plugs into a separate connector, which contains the I/O ports accessible from the back of the monitor.

The SLC board uses a 20-MHz version of the SPARC processor and a slightly slower FPU than on the SPARCStation 1 (the FPU on the SLC is rated at 1.0 million floating-point operations per second, compared to about 1.5 MFLOPS for the SPARCStation 1). [Editor's note: *In conjunction with the introduction of the SLC, Sun Microsystems also announced that the SPARCStation 1 now comes standard with a 25-MHz processor, giving the SPARCStation 1 a performance rating of over 15 MIPS. There is no price increase for the faster-CPU version of the SPARCStation 1.*]

Sun demonstrated the SPARCStation SLC running Sun's graphical user inter-

PHOTO COURTESY OF SUN MICROSYSTEMS, INC.

A diskless version of Sun's SPARCStation has most of the power of the original, but with a small price tag

face, Open Windows. The high-resolution monochrome monitor, which has a resolution of 1152 by 900 pixels with 100 pixels per inch, provided excellent contrast and readability. Since there is no fan, the SLC is totally quiet.

Although the SPARCStation SLC is competitively priced, it does have its limitations. It is clearly designed for use in a networked environment as a node on the network. Although you could use the SLC as a stand-alone system, it would make more sense for most customers to buy the higher-performance SPARCStation 1 for stand-alone use. Here's why. First, as the integral monochrome monitor might suggest, the SLC is strictly a monochrome machine. Even if you wanted to add an external color display, the SLC lacks the S-Bus slots required by SPARCStation color and graphics accelerator boards. Second, the disk storage transfer rates are limited on the SLC. Although you can connect external storage devices such as hard disk drives, tape drives, or Sun's new SunCD CD-ROM drive via the SCSI port, you're limited to the 1.5-megabyte-per-second data transfer rate of the SCSI bus, whereas the full SPARCStation with the S-Bus allows transfer rates of up to 80 MBps. And, finally, there's no option for attaching a floppy disk drive to the SLC.

For networked environments, however, the SPARCStation SLC is ideal and costs about $4000 less than an equivalently configured SPARCStation 1.

Sun representatives acknowledged that terminals running X Window System applications off network servers are a major competitive target for the SLC. The SLC has an obvious advantage over an X Window System terminal, which has no independent processing capability. X Window System terminals promote the age-old minicomputer concept of "time-sharing," or multiple terminals sharing the processor resources of a single host computer or file server. The problem with time-sharing is that it is easy to overload the host processor with too many users running applications simultaneously, resulting in performance degradation for the whole system.

The SPARCStation SLC, on the other hand, offers independent processing power in addition to network connectivity, allowing the user to have access to data and applications on the network in addition to the ability to process these applications and data independently. Although X Window System terminals are priced in the range of $2000 to $3000, the additional cost of the SPARCStation SLC is well worth the advantages that come with it.

Of course, diskless workstations are nothing new. But the SPARCStation SLC offers a new level of processing power at a low price. In addition, the simple and elegant packaging of the SPARCStation SLC makes it an ideal system for an office network of SPARC workstations. ■

Nick Baran is BYTE's West Coast bureau chief. You can contact him on BIX as "nickbaran."

COMPANY INFORMATION

Sun Microsystems, Inc.
2550 Garcia Ave.
Mountain View, CA 94043
(415) 960-1300
Inquiry 860.

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Networks of Peers

Flexible, low-cost LANs do their fair share

Jon Udell
and Rob Mitchell

Low-cost, peer-to-peer LAN: You have heard the phrase time and again. But stop and think for a minute. Is there some necessary connection between price and peer capability? No. Unix LANs are always networks of peers, although they're hardly cheap. The peer model—a network in which every node can both provide and use network resources—confers far more flexibility than a network based on a dedicated server.

Why, then, don't all PC and Macintosh LANs work that way? Vendors of dedicated-server LANs argue, with justification, that neither DOS nor the Mac OS can reliably sustain an intensive mix of both server and client activities. So they divide the world into servers (running NetWare, OS/2, or Unix) and clients (running DOS, Windows, or the Mac OS). As true client-server applications evolve—and they're coming fast—that approach will pay off.

But let's focus on budget LANs that you can buy and use today. Suppose your office uses five or six AT-class PCs. Several of the PCs control files or devices (resources) that everyone in the office would like to share: a database, a laser printer, a CD-ROM drive, a tape drive. Take heart: You don't have to spend a lot of money on a dedicated server, Ethernet hardware, or a foreign operating system.

The PC and Macintosh LANs that we examine this month transform collections of PCs or Macs into surprisingly useful networks. Operating-system limitations notwithstanding, they deliver peer services that their high-end, server-based counterparts typically don't provide. If you're in the market for an enterprise-wide network that will run client-server applications, these peer LANs aren't the answer. But if you're looking for ways to build small- to medium-size workgroups, read on.

The Products

To select products for this project, we settled on two main criteria. The first criterion was price: For a five-node network, none of these LANs will cost you more than $320 per computer (a list of features appears in tables 1 and 2). (On a cost basis, TOPS/DOS didn't fall into our range, but we included it because of its unique ability to integrate Macs and PCs.) The second criterion was peer capability: Any machine attached to the LAN can share its files or printers and still run its users' programs acceptably. We found six DOS peer LANs that met the cost criterion: GV LAN OS, LANsmart, LANtastic, MainLAN, Net/30, ReadyNet, and TOPS/DOS. On the Mac side, we tested Personal Service Network (PSN) and TOPS.

If you've already invested in a server-based network but need peer services, see the text box "Adding Peer Services to a Server-Based LAN" on page 146.

Tests and Tasks

To test the DOS LANs, we outfitted an office with four PCs—a Compaq 286e, a Dell System 325, and a pair of Gateway 2000s (12-MHz 286 systems). Each machine played a specific role. Equipped with a Mountain tape drive, the Compaq's job was to back up the whole network. The Dell was our database server. One Gateway acted as print server, and the other was our CD-ROM server.

You could load all the shared resources onto a single machine and dedicate it as a server—nothing prevents you from using a peer LAN that way. But we assumed that our imaginary office couldn't afford a fifth computer and couldn't sacrifice one of the existing four. The idea was to start with four useful PCs, connect them, and still have four useful PCs. So we distributed the resource-sharing load equitably among them.

We ran two throughput tests. The network file I/O test does random reads and writes according to a pattern that's designed to simulate the behavior of typical applications. The database test runs a FoxBase program on four stations concurrently, dumping records from shared databases. The results of these tests appear in table 3, but the numbers don't convey the feel of these networks. As an illustration, load a program (e.g., a text editor) from a remote drive, and then from a local drive. Even on "slow" twisted-pair cabling, the best of these networks respond so fast that remote and local program loads feel about the same.

Apart from performance, what differentiates one network from another? Plenty of things: ease of installation; documentation; memory consumption; cache capability; level of support for multiuser file access; range and quality of administrative, mail, and printer/spooler services; and grace under pressure.

To get to know these networks intimately, we specified a profile for each machine that defined which resources it shared (and to whom, on what basis) and the resources it used. For example, the backup machine needed total read access to the hard disks of all other machines. But the other three servers shared their disks with one another more selectively. We wanted the print server to connect to its locally attached printer through the network, to prevent conflicts between local and remote print jobs.

For each of the networks, establishing each machine's configuration of shared and acquired resources demanded a lot of

continued

PHOTOGRAPHY: PAUL AVIS/GRAPHIC ART: JOSEPH GALLAGHER

FEATURES TABLE

Table 1: Not all peer LANs are created equal, nor do they always fit neatly into a table. A few caveats are in order. DOS memory requirements vary with each user's configuration, so we give a range within which most users will fall when configured as a client only or as a client and server. We calculated memory use for a base (640K-byte) system; this didn't include the effects of EMS, shadow RAM, or extended memory support. Our figures include NetBIOS as well as the client and server software. If you plan to use multiuser software such as FoxBase Plus, all products except GV LAN OS and ReadyNet require running the DOS Share program, which adds 6K–12K bytes to memory overhead (●=yes; ○=no).

	GV LAN OS 1.1	LANsmart 2.0	LANtastic 2.57	MainLAN 2.14	Net/30 1.52	ReadyNet 1.0 rel. 6.256 rev. C	TOPS/DOS 3.0
Price per node (five users)	$320	$216	$265	$220	$215	$250	$439
HARDWARE							
Type	ARCnet	ARCnet-compatible	Proprietary	Proprietary	Proprietary	Proprietary	Proprietary
Rated throughput (Mbps)	2.5	2.5	2	4	1.8	1	768,000 bps
Cabling	RG 62 coaxial	Twisted-pair	Twisted-pair	Twisted-pair	Twisted-pair	Twisted-pair	Twisted-pair
DMA channel(s)	○	○	○	○	1	○	1 or 3
Interrupts supported	2,3,4,5,7	2,3,4,5,7	2,3,4,5,6,7, 10,15	2 or 3	2 or 3	2,3,4,5,7	2 or 3
Diagnostics software	●	○	●	●	●	●	●
Maximum nodes	250	16	120	62	45	24	32
Supports other network cards	●	●	●	●	●	●	●
NETWORK SOFTWARE							
Memory use (observed)							
Server/client	67K-122K	130K-180K	40K-80K	100K-200K	82K-120K	170K-250K	290K-350K
Client only	67K-122K	70K+	14K+	60K-200K	62K-80K	66K+	200K-250K
Network software loads							
to EMS memory	●	○	○	○	●	●	●[1]
to shadow RAM	○	Optional	○	○	●[2]	○	○
to extended memeory	○	●	○	○	○	○	○
Server disk cache	○	●	○	○	○	●	○
Interface							
Command language	○[3]	●	●	○	●	○	●
Menu	●	●	●	●	●	●	●
Loadable as TSR?	●[4]	●	●[5]	●	○	○	○
Software unloadable without rebooting	○	●	○	○	○[6]	○	●
NetBIOS support	●[7]	●	●	●	●	●	●
Automatic reconnection	●	●	●	○	○	●	○
PRINTING							
View print queue	●	●	●	●	●	○[8]	●
Modify print queue	●	●	●	●	●	○	●
Set end-of-file time-out	○	●	●	●	●	○	●
XON/XOFF flow control	○	○	○	○	●	○	○[9]
ADMINISTRATIVE							
Resource auditing	○	○	●	○	○	○	○
Server reboot protection	●	●	●	●	○	○	○
List open files on server	○[10]	●	○[10]	○	○	●	○
Close open files on server	○	●	○[11]	○	○	●	○
MAIL							
Store and forward	●	●	○	●	○	●	●
Broadcast	●	●	●	●	○	●	●
Attach files	●	○	●	●[12]	○	○	●
Edit message	●	●	○	●	○	●	●
Save messages to a file	●	●	○	●	○	○	●
MISCELLANEOUS FEATURES							
Remote control of other nodes	○	Optional	Optional	○	○	●	○
Diskless workstations	Optional	Optional	Optional	○	●	○	○
On-line conferencing	○	●	○	○	○	○	○
Telephone support	One call	Unlimited	30 days	90 days	Unlimited	30 days	Unlimited
Warranty	90 days, hardware only	1 year, hardware only	1 year, hardware only	1 year, hardware only	1 year, hardware only	1 year, hardware only	1 year, hardware; 90 days, software

[1] Software loads to EMS or extended memory.
[2] Loads only to shadow RAM. Optional software loads network operating system to shadow RAM.
[3] GV LAN OS has some command-line options but relies on menus for most functions.
[4] Menu program runs only as a TSR.
[5] TSR menu utility is a subset of the main menu program.
[6] Pause option halts network operation but doesn't unload software from memory.
[7] Partial NetBIOS implementation. Extended NetBIOS version available at no charge.
[8] Print spooler not included with ReadyNet. Spooler program is available at no charge.
[9] XON/XOFF not needed—TOPS supports serial printers directly.
[10] Software issues warning if files are open on server before allowing reboot.
[11] Procedure requires rebooting server.
[12] Can attach only ASCII text files to mail messages.

patience—and we are relatively savvy LAN installers. If the vendors really expect end users to install and configure these LANs, they ought to improve their documentation. In general, the manuals sorely disappointed us. If you're handy with DOS, batch files, and peripherals, you'll muddle through, but not happily.

We then asked the following questions of each network: Can it run FoxBase interactively on four stations against files stored on the database server? What happens when you shut down a client who is holding a lock on a server-resident database record? Will the server clear the lock? Is there protection against Control-Alt-Delete rebooting a server? Will the network software reconnect to a remote drive after its server has rebooted? What queue control facilities are available? Can you print documents across the network from XyWrite? From PageMaker? Can you access a CD-ROM drive across the network? How does the E-mail system work? How well does the system perform on a multipurpose test, with all stations running intensive server and client tasks?

These are the sorts of questions that you will confront when you move your day-to-day operations onto a LAN. The answers matter more, in our opinion, than raw benchmark numbers.

LANtastic

Artisoft's smart 2-megabit-per-second network adapter, built around a 10-MHz Z180, helped make LANtastic the smallest network program that we tested. The backup machine used just 14K bytes of RAM, and the servers around 40K bytes. LANtastic's ability to off-load network processing to the adapter accounts for its remarkable compactness. While that coprocessor-based scheme didn't yield outstanding performance, it helps explain why LANtastic was also one of the most reliable networks. DOS can multitask, but the less you expect of it, the better.

Most LANtastic installations today run on 2-Mbps adapters, but the software works identically on 10-Mbps Ethernet hardware. That's an increasingly popular choice, according to Artisoft.

One switch on the 2-Mbps adapter controls the I/O port that the board uses. Software switches (arguments to LANtastic's driver program) control the interrupt request line and the address of the 32K-byte block of RAM shared between the adapter and the PC.

Network adapters come preconfigured with default settings that usually work. When they don't—that is, when the network hardware fights with what's in your machine for interrupts, ports, or memory—something has to give. Then, two factors come into play. What alternate settings can the adapter use? How easily can you change the settings? In all cases, LANtastic provides a wide range of choices. With the exception of the I/O port, you can modify hardware settings under software control. You'll appreciate that when things don't work right out of the box. For example, on the Dell System 325, the adapter's default RAM address gave Microsoft Windows grief. We easily moved the adapter's RAM to a better location. We didn't notice the Windows

continued

MAC LAN OPERATING SYSTEMS

Table 2: Both TOPS and PSN support the AppleShare Filing Protocol (AFP). PSN also uses the AppleShare client interface.

	TOPS 3.0	PSN 1.1
Auto-install/remove	●	●
Desk accessory interface	●	●
Despooler/queue manager	●	○
E-mail	●	○
AFP-compliant	●	●
AppleShare-compatible	○	●
Share CD-ROM	●	○
List users of published volume	●	●
Minimum Mac	Plus	Plus
Minimum Mac recommended for server	SE	SE
Memory required	1 MB	1 MB
Memory recommended for server	2 MB	2 MB

PC PEER LAN PERFORMANCE

Table 3: BYTE's network file I/O tests read and write files of random size from a 12-MHz 286-based client machine to 12- and 25-MHz 386-based servers, respectively. Most LANs performed similarly during these node-to-node file transfers, but when we loaded the network during the database tests, GV LAN OS and Net/30 were the clear winners. We tuned each network for optimum performance. With LANtastic, better file I/O performance came at the expense of the database speed. In that case, we optimized for the best database performance. Times are in seconds. Not every product could run the database tests. ReadyNet had insufficient memory to run FoxBase Plus, and LANsmart couldn't run the FoxBase tests because of reliability problems.

	Network file I/O test				Database test			
	386 server		286 server					
LAN	Read	Write	Read	Write	Compaq 286e (backup server)	Dell 325 (Database server)	Gateway 2000 (print server)	Gateway 2000 (CD-ROM server)
Baseline (local disk)	N/A	N/A	N/A	N/A	N/A	21	N/A	N/A
GV LAN OS	16	14	60	21	64	33	79	67
LANsmart	16	10	44	16	N/A	N/A	N/A	N/A
LANtastic	27	17	52	19	123	40	120	126
MainLAN	17	7	43	27	126	112	126	122
Net/30	16	14	55	22	75	85	82	81
ReadyNet	181	63	141	37	N/A	N/A	N/A	N/A

N/A = Not applicable.

Adding Peer Services to a Server-Based LAN

Novell's NetWare, IBM's PC LAN, 3Com's 3+Open, and other leading networks don't implement the flexible peer model that we focus on this month. They require dedicated, central file servers. To move a file from one client workstation to another requires two steps: Copy to the server, and then copy from the server.

Point-to-point file sharing between any two client workstations adds tremendous utility to a server-based network. Tape backups benefit because you eliminate one transfer step and do not need to maintain lots of intermediate storage on the server. CD-ROM sharing becomes possible even on a network that, like Novell's, can't hang CD-ROM drives on the file server.

Two relatively new products, Map Assist and Pipes Drive, deliver the benefits of a peer network in a server-based environment. Map Assist works only with Novell's IPX transport protocol. Pipes Drive can use IPX or NetBIOS-based protocols.

Both do basically the same job. A TSR program that you load on one workstation turns it into a pseudoserver. You can then publish a drive. To publish a read/write with Map Assist, you use

```
mahost C:* RW=/
```

With Pipes Drive, you use the following:

```
drive public c: as Jon_C
```

A companion program running on another station mounts the published volume. Map Assist requires the network name of the user who owns the resource. If user Jon issued the `mahost` command, then another user can map his or her drive Q to Jon's C, like this:

```
ma q:=jon
```

And with Pipes Drive, since the resource itself already has a name, you just type the following:

```
drive use Jon_C as q:
```

We've used both programs to perform station-to-station tape backups and to share CD-ROM drives. Although either will get the job done, Pipes Drive's protocol independence makes it the more flexible tool. It is built around The Lambda Group's ambitious Pipes NDOS—a "nested distributed operating system"—intended to support peer services across a variety of operating systems and network transport protocols.

conflict right away. We had already installed the network. Without a software switch, we would have had to pull the card—possibly more than once.

Peer networks subscribe to one of two resource-sharing philosophies. Some consider a machine's disks and printers public, subject to restrictions. Others consider those resources private, subject to permissions. Like most of the networks we reviewed, LANtastic assumes that your machine is private property. You can tell it otherwise by means of `net_mgr`, a menu-driven utility that creates accounts for users of your machine (a required step) and specifies which directories and printers they can access.

The `net_mgr` utility manages shared resources as a set of aliases, or name-value pairs. For example, `netbin` could refer to `c:netbin`, and `@epson` to LPT1. Clients depend only on the names. That means that if a server moves `netbin` to `d:mybin`, or `@epson` to LPT2, clients will not need to change their log-in scripts. *Access control lists* associated with resources govern who can do what with them. Once you publish a resource, all users have full rights unless you specify otherwise through ACL definitions.

From the client's perspective, the menu-driven `net` utility (or, from the command line, `net use`) maps local drives and printers to published resources. You can specify the server and resource name,

```
net use f: \\susanna\netbin
```

or just the server:

```
net use f: \\susanna
```

Omit the resource name, and you associate your local drive with *all* published directories. The many-to-one relationship between server resources and local drive letters makes it convenient for a server to share just portions of its disk.

LANtastic manages mail and print queues similarly, and that confused us a bit. No "send mail" command exists. Instead, you use the `net` utility to locate a server with a mail queue, select that queue, and then press the Insert key to signify that you want to make an entry in that queue. Then you can type a quick note or name a file that you want to transmit. On the receiving end, you've got to prowl through the mail queue, notice that entries exist (there's no "you have mail" alert), and then view them by means of the queue manager's read command.

You can use the same methods to insert and retrieve print queue entries. Normally, a printing application inserts entries into the print queue, and the network's despooler removes and prints them. The print/mail synergy has at least one advantage. The same mechanism that reads mail can also peek at the contents of an entry in the print queue. But it's a quirky setup, especially since some menu choices don't make sense in both contexts. LANtastic won't prevent you from trying to *hold* a mail queue entry, but it will grumble about an "invalid menu choice."

LANtastic was one of several networks we tested that enable a server to share a CD-ROM drive, but it was the only one that provided explicit CD-ROM support. You can tell `net_mgr` that a shared resource is a CD-ROM drive—a nice touch.

LANtastic's manual even tells you when in the boot sequence you should run the CD-ROM extensions. That varies from network to network; only LANtastic bothered to mention it.

Despite the valuable CD-ROM tip, though, LANtastic's manual needs a rewrite and an index. We flipped through it countless times looking for things that we remembered reading but couldn't find. Particularly frustrating was the sketchy coverage of performance tuning. LANtastic isn't unique in this regard. Many networks provide an assortment of knobs and switches, but little guidance as to how to use them. We found LANtastic surprisingly slow on our database

continued

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test, and we fiddled with coprocessor, server, and redirector buffers to see if we could improve matters. Eventually we did—at the expense of the file I/O benchmark—but strictly by trial and error. Artisoft claims that other database products work better with LANtastic than FoxBase does.

In fairness to LANtastic and the rest, the environment in which a DOS networking program operates—one that can include a variety of disk caches, memory managers, and ill-behaved applications—defies easy generalization. Still, specific recommendations for tuning a network for popular applications and tools would be extremely helpful.

Despite these quibbles, we liked LANtastic. It's fast enough, and it's robust. On a busy multiple-server network, everything ran smoothly. We thought that client and server tasks coexisted more happily here than on any of the other networks.

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ReadyNet

Corvus Systems markets ReadyNet as "the incredible self-installing LAN." In a sense, that's true. With the starter kit, you can get a two-node network up and running with very little time and effort. Just drop in the cards, plug in the cables, install the software, and go. There's no need to create user accounts or even establish connections: ReadyNet automatically maps the client's drive F to the server's C, and the client's LPT1 to the server's LPT1.

But when you add nodes and configure for multiple servers, things get complicated quickly. The first surprise was the cabling. Corvus offers 1- and 4-Mbps twisted-pair cabling, running the proprietary Omninet protocol that ReadyNet shares with its big brother, PC/NOS. With Omninet, short cable segments connect interface cards to junction boxes; longer cables tie these boxes together into a backbone.

Unfortunately, the extension cable that comes with the 1-Mbps system does not have connectors that match the sockets on the junction box—only the 4-Mbps version works that way. Instead, the cable ends in bare wires. To extend the backbone, you must pry open a junction box, remove a terminating resistor, lift two clamps, insert the positive and negative leads, and clamp them down. We sympathize with users who must reconcile marketing claims such as "self-installing" and "no tools required" with the reality as depicted in the Add-On Guide. One figure shows a screwdriver prying open a junction box, and another illustrates the removal of a resistor.

Once you have cabled your system, ReadyNet's diagnostic program does a good job of checking out the integrity of the cards and of the connections between them. Now you're ready to install the software. It's copy-protected, and you'll want to label the disks that come with each add-on kit, since they carry unique workstation identities.

The next surprise was that ReadyNet wouldn't install on the Compaq 286e. ReadyNet won't work with the Compaq DOS 3.31 that ships with that machine, or indeed with any version of DOS (including 4.0) that boosts the size of a sector beyond 512 bytes and the size of a partition beyond 32 megabytes. ReadyNet's built-in caching scheme works directly with your hard disk. On a server, ReadyNet bypasses DOS's file system and tracks disk cluster usage directly. This consumes memory in proportion to the size of the shared volume. If some

continued

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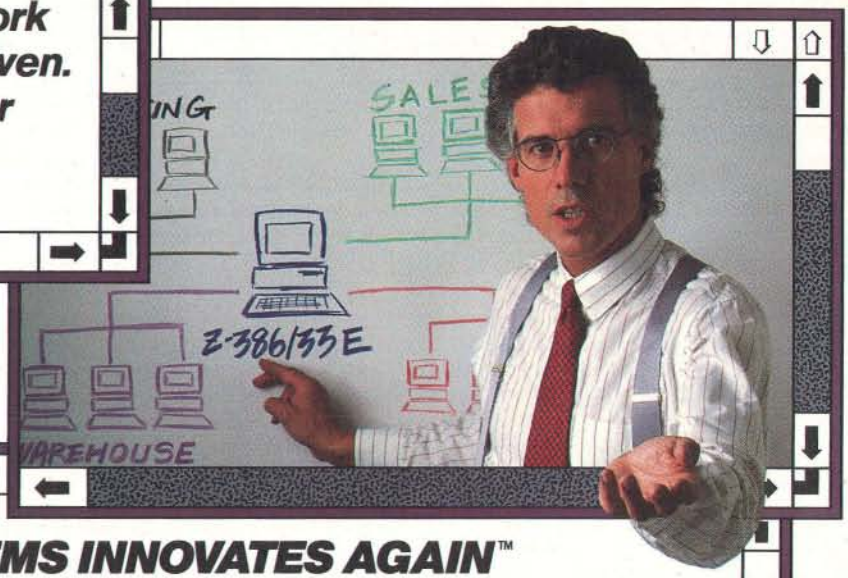

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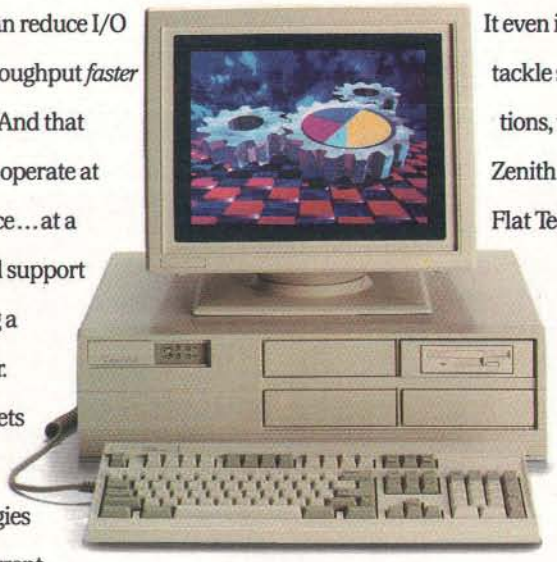

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compelling performance advantage flowed from this strategy—which also precludes CD-ROM support—it would make sense. But we found ReadyNet slower than average.

Additional complications arise when you want to establish new client-server connections. ReadyNet's methods and terminology were among the most obscure we encountered. *Plugs*, *sockets*, and *modules* add unnecessary weight to the syntax that defines connections. Compare LANtastic's

```
net use f: \\Susanna
net use LPT1\\Debbi\@Epson
```

with ReadyNet's

```
/msdos/F: = /node3/msdos/C:
/msdos/LPT1 =
/node1/printsrv/printer1
```

For starters, ReadyNet hard-wires the machine names as "node1," "node2," and so on, and there's no way to switch to more intuitive names like "Susanna" and "Debbi." Similarly, you're stuck with printers that are called "printer1" and "printer2"; there's no way to use meaningful names like "Epson" and "LaserWriter." Then, there are the plugs, sockets, and modules. The printer connection, for example, says, literally, "connect the LPT1 *plug* in the MS-DOS *module* of the local node to the printer1 *socket* in node3's printsrv *module*." The explicit module names impose an engineer's view. The software does in fact comprise such modules, but users need not know that and won't care.

In part because of ReadyNet's disk cache, servers need a lot of memory. You can offset that with EMS memory, so we were able to run FoxBase on the Dell, which (for all the networks) we configured with 1 MB of expanded memory. But the two 640K-byte Gateway 2000 machines, operating as servers, couldn't load FoxBase, so we can't report results for the database test. We did reconfigure one Gateway as a workstation, and we ran FoxBase there against database files stored on the Dell to verify that ReadyNet could handle sharing and locking correctly. It did.

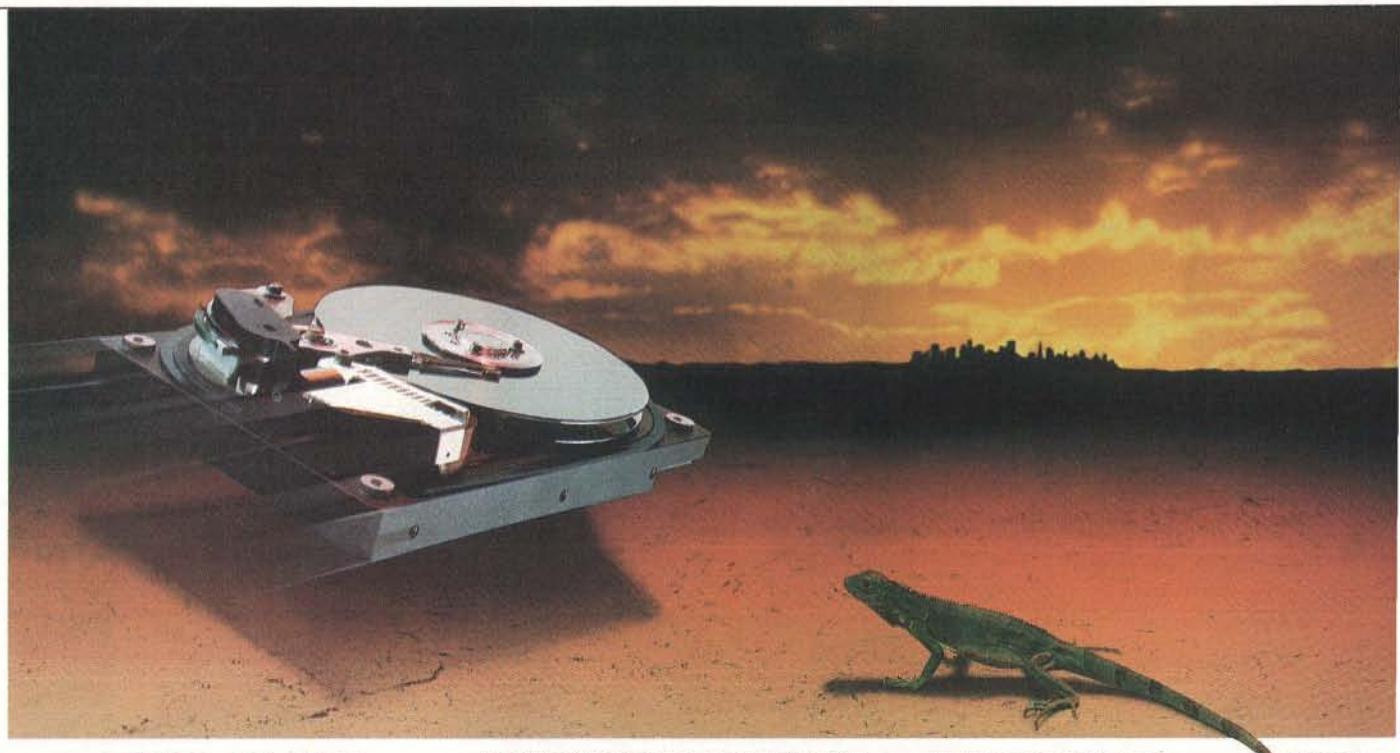
Of the networks that we reviewed, only ReadyNet came with remote control software that commandeers another station's screen and keyboard. It's a useful feature, but it costs an additional 40K bytes of RAM, and on the 1-Mbps system we tested, it ran slowly. The mail system can store and forward short messages, so you can communicate with users who aren't on-line. We found no evidence of a spooler or queue manager in either the software or the documentation. Corvus told us that there is a spooler module, but that it was inadvertently left out of the 1-Mbps version of the package. We had not received it by press time.

It's quite possible that some users require no more than what the ReadyNet starter kit does—and does painlessly. But we can't recommend the product for larger workgroups or for intensive use in a multiserver configuration.

Net/30

Net/30 wasn't as small as LANtastic, but it ran faster and just as reliably. We did manage to reduce the size of Net/30 on our database server from 110K bytes to 55K bytes by using EMS memory. If your computer is equipped with a Chips

continued



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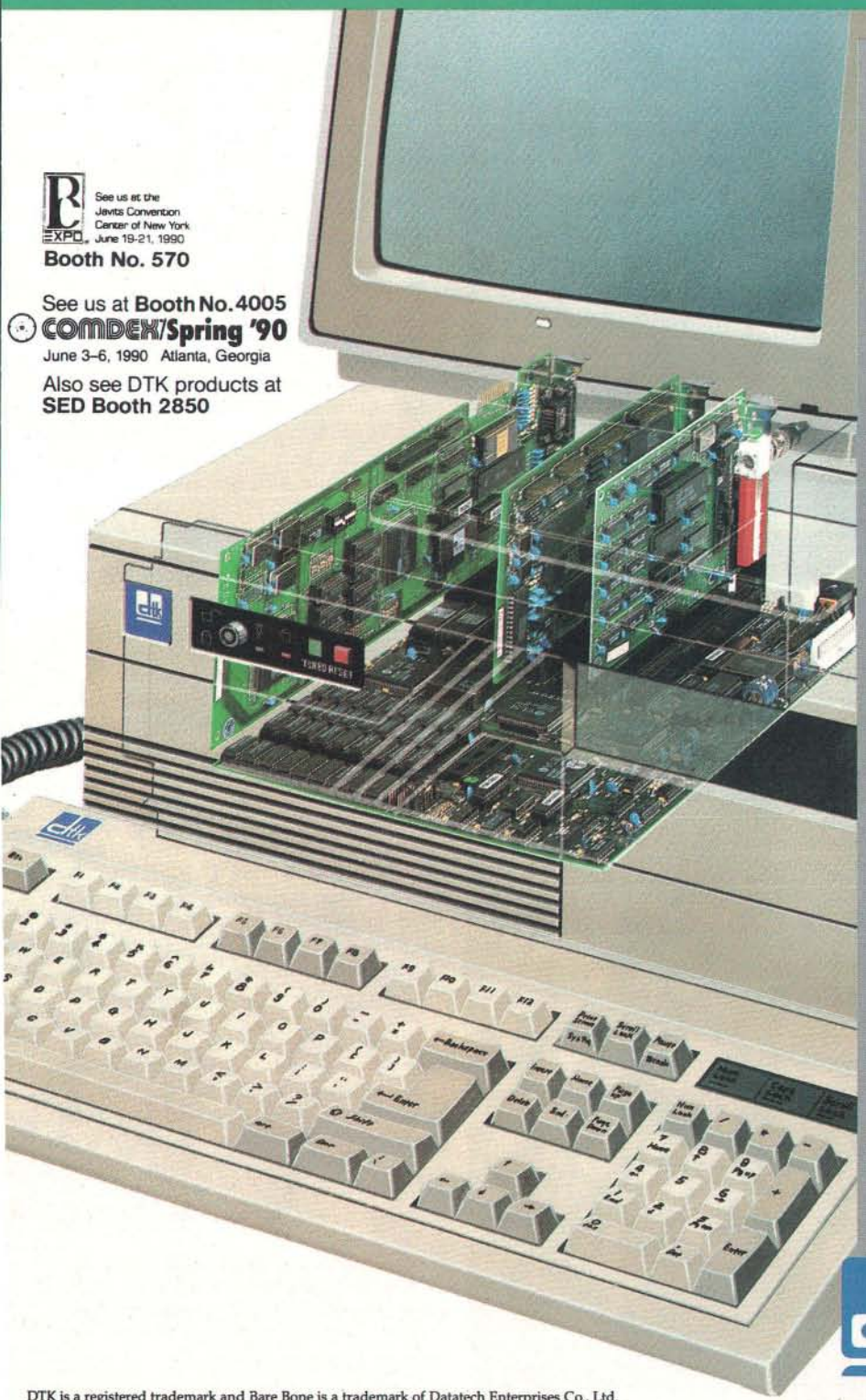

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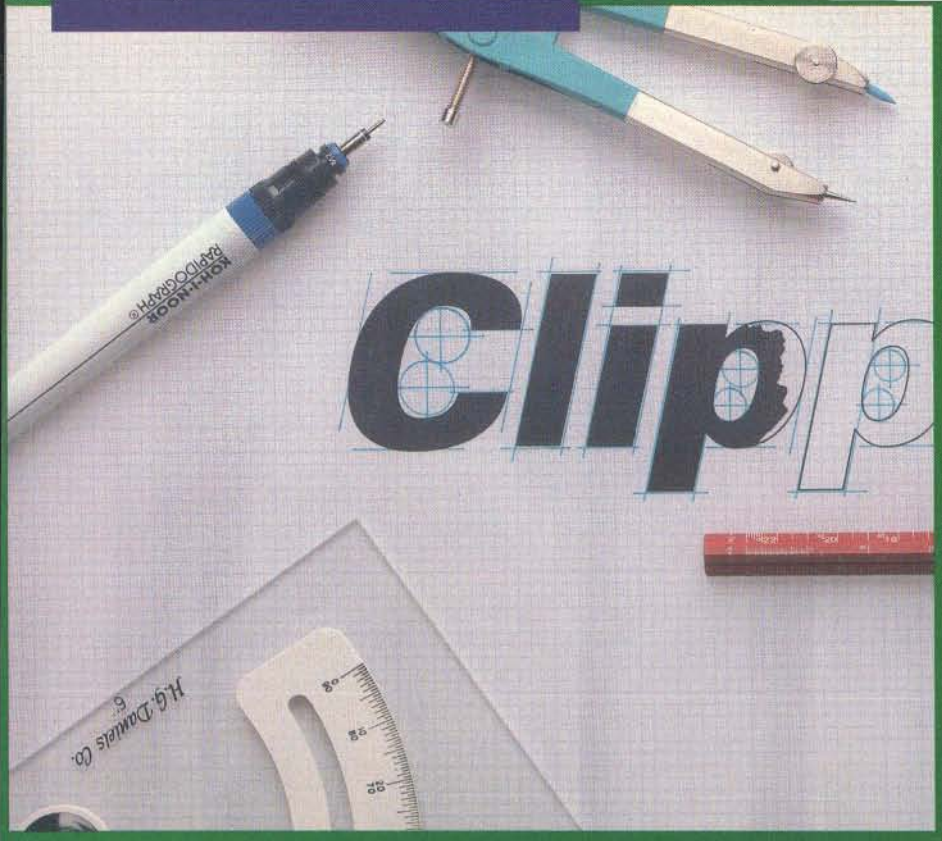

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& Technologies NEAT or AT/386 chip set, Net/30 can load NetBIOS into shadow RAM. We did that with the printer and CD-ROM servers and cut RAM consumption from 100K bytes to 50K bytes. Invisible Software claims that an optional program—which we didn't test—can move much of the redirector and server code to shadow RAM as well.

We ran Net/30 on proprietary 1.8-Mbps network cards and twisted-pair cable. The cards were self-terminating and included NetBIOS in ROM. The ROM NetBIOS saved memory, but it slowed performance and didn't work with PCs at clock speeds faster than 12 MHz. We opted to run NetBIOS from RAM.

Each card requires a unique address that you set by means of DIP switches. One card becomes the master; you must power up that machine before bringing up the rest of the network. A utility program, `netpoll`, checks out the connections between cards.

Quick-start batch files simplify installation of basic printer- and file-sharing services. But we struggled to configure the network to our specification. The manual wasn't enlightening, particularly on the subject of EMS and shadow RAM. Net/30 copy-protects the software, so, again, you have to keep track of which disk belongs to which machine.

Servers come in small, medium, and large sizes. Each allots progressively more sessions and file handles. Our printer and CD-ROM servers used the minimum version, and the database server—which had to support more open files—used the standard version. We did not use the large version, which creates a dedicated server.

Net/30's default configuration makes all server resources public. Clients use `map` (at the command line) or `menu` to acquire resources. With either utility you can view and modify drive and printer mappings, manipulate print queues, restrict access to shared resources, and remotely manage workstations.

Although the documentation didn't mention support for CD-ROM drives, we had no trouble sharing ours with the network. Our network backup test also worked fine. But if your tape backup system won't recognize network drives, Net/30's `nw hide` command might help. It makes network drives look like local drives.

Net/30 was the only product we reviewed that offered XON/XOFF (software) as well as DTR (hardware) flow control for serial printers. You control printing from two menus: One operates the spooler, and the other controls the

print queue. The spooler menu has the ability to pause, restart, or clear the queue, but you must switch to the print queue menu to reorder or delete jobs. You can restrict access to the spooler and queue manager, but only on an all-or-none basis. Users with queue privileges see all jobs in the queue, not just their own.

Only Net/30 supported remote management. That means you can reach across the network and alter any station's configuration of shared and used resources. This feature can save a lot of foot traffic in an office. But if you don't want other people remotely managing your station, you (or your remote manager) will have to explicitly prevent that.

Net/30's security system was the most comprehensive and most complex that we tested. Unless you want a *completely* open network, you'll have to battle with this thorny process. You assign an alias to each shared resource, deny access permissions to *everyone*, and then enable access for selected users. We suspect that many users will follow the path of least resistance and simply ignore Net/30's security features.

With `mail`, a primitive message program, you can send short (76-character) messages to other users who are on-line and running `mail`. It's a 5K-byte TSR and isn't unloadable. You can't save or edit messages or attach files. When you receive a message, `mail` displays the sender's message and waits for your response. You can reply, send new mail, or quit. You can't broadcast messages to multiple users. The `mail` program works only when the sender's and receiver's displays are in 80-column text mode.

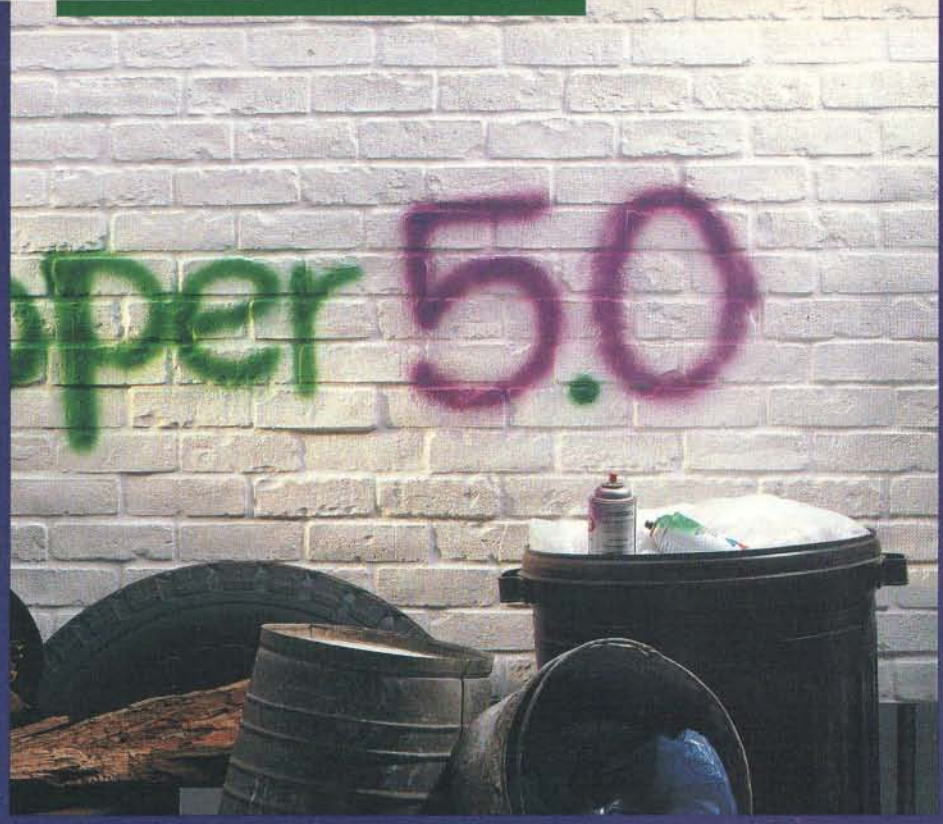
Net/30 lacks some niceties: It won't prevent you from rebooting a server, workstations don't automatically reconnect when a server comes back on-line, and you can't check for open files on a server or explicitly close files left open. Although it didn't offer a server disk cache, Net/30 outperformed other LANs that did.

Overall, Net/30 impressed us. Only GV LAN ran our database test faster. The multipurpose test ran flawlessly. We confidently recommend Net/30 for multiserver peer networks.

LANsmart

Ideally, a network operating system should provide both command-line and menu interfaces, and D-Link's LANsmart does. Menus and commands are just two sides of the same coin; you can use either method without limitations.

continued



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While your left brain duly notes the benefits of Clipper programming, the right half is wild about how you get them! Imagine a programming environment with no limits. The language can be easily extended with your own routines and you can even integrate code from other languages, like C and Assembler. You're always free to configure Clipper to suit your own programming style.

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The basic server requires 130K bytes and can balloon up to over 180K bytes. Nodes that don't need to share resources can get by with about 30K bytes. You can shrink the program in several ways, none of them documented. On our database server, an extended memory driver brought LANsmart's RAM footprint from 174K bytes to 115K bytes. Neatplus ($50), an optional program that we didn't test, works with shadow RAM on Chips & Technologies hardware. D-Link claims that it achieves a comparable reduction.

We used D-Link's 2.5-Mbps ARCnet cards and daisy chained them together with twisted-pair wire. The cards had plenty of alternate jumper settings to handle conflicts, but D-Link didn't include a low-level diagnostics program to test the cards.

The LANsmart disks came with an installation program, but the manual did not document that. Instead, it instructs you to copy files manually to a subdirectory. That's not bad in itself. Automatic installers often take liberties with your system in the name of "ease of use." We prefer to do it ourselves, but, either way, we expect documentation to spell out what components go where. Too often, manuals don't tell all; LANsmart's is no exception.

We had our share of problems getting LANsmart running. The network software won't coexist with Microsoft's CD-ROM driver, so you can't share a CD-ROM drive with the network. Moreover, you cannot use a CD-ROM drive locally unless you unload the network software. LANsmart fought with SMARTDRV .SYS, so we ran our database server without it. We weren't cacheless, though; the program provides its own.

LANsmart's `netshare` command works with resource names. The `connect` command maps local drives and devices to names and displays a list of published resources. Tunable options include disk cache, network buffer, and print buffer.

LANsmart handles lost connections well. When we shut down a server and brought it back on-line, workstations reconnected to it transparently. By contrast, some other networks forced us to manually reconnect or, worse, to reboot. If a client crashes, leaving open files or active locks, you can use LANsmart's `file` utility to close them gracefully. Only LANsmart offered this valuable feature.

We did experience a lot of flakiness, though. Sporadically, machines hung while loading the network software or crashed when we tried to reboot them. When more than two machines ran network-related processes concurrently, connections tended to break and workstations again hung. That's why the test results for LANsmart include no numbers for the database test: We couldn't consistently run the program on all four stations at once. D-Link's engineers tracked the loading problem to a bug in the new DX-100 card's driver software and assured us that LANsmart works fine with their other network cards. A fix arrived too late for retesting.

Ideally, a network operating system should provide both command-line and menu interfaces.

With LANsmart's queue manager, users can see and modify just their own print jobs. The owner of a print queue can reorder print jobs or (unique to LANsmart) redirect a job to a different printer.

The mail facility can send a one-line message to an individual user, or broadcast it. Received messages time out after 15 seconds, so a workstation can continue processing if the recipient isn't home. When the recipient presses a key, the message reappears. Most other networks hang the receiving workstation until the recipient acknowledges the message.

Another convenience is `chat`, a split-screen conferencing system for up to four users. Users can save a transcript of chat sessions to disk. All participants have to load their own copy of `chat`.

LANsmart left us with mixed feelings. We liked its symmetrical command/menu interface and its excellent handling of lost connections and open files. But even with extended memory to play with—and that's not an option for many users—a LANsmart server doesn't leave much room for client tasks.

GV LAN OS

With Grapevine's GV LAN OS, there's no need for script files to load NetBIOS, Share, redirector, and server modules. Just type `gv`, and you're on the network. From there, GV LAN OS's 122K-byte RAM-resident menu program is just a hot key away. By means of pull-down menus, you set network control parameters, share and acquire network resources, apply access restrictions, and send or receive mail. A menu option saves drive mappings and other configuration information so that you don't have to bother with them again.

To lighten the memory burden, you can run `gvsmall`. It sheds the menus and frees up about 50K bytes. But then you're left with just a handful of commands. You can change drive mappings and printer connections and see who's on-line. To send mail, control print queues, or share resources, you have to reload the menu system.

Grapevine's 2.5-Mbps ARCnet cards include interfaces for twisted-pair or standard RG-62 coaxial cable. Our setup included coaxial cable, which we laid out in a bus topology using supplied BNC T-connectors. The manuals do not provide any information on resolving configuration contentions, but the cards have plenty of alternate settings. An undocumented network-level diagnostic utility helped us check network connections but conflicted with GV LAN OS's installer. After we used it, we had to reboot all machines to install the network software properly.

The installer detects EMS memory and loads about 40K bytes of GV LAN OS into expanded memory. But GV LAN OS won't share EMS memory; running other programs that use EMS will cause conflicts.

Grapevine avoids sharenames in favor of direct mappings to the shared drive and path. Drives shared to the network are either public or password-protected, and they can have read, write, and create access restrictions. There's no facility for publishing shared resources to the network, so each user has to know what's available.

Unlike directories, printers are automatically public—and this confused us. You simply reach across the network and grab another machine's printer port. It took us a while to figure out that the "device installation" menu referred to remote, not local, devices. For example, to reach our print server's Epson from the database server, we had to execute an "install" procedure on the database server, specifying LPT1 as the connection. It's a quirky method—the more so since *all* local ports map to the remote one. We much prefer attaching to an

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abstract name, such as \\Debbi\Epson. Moreover, funneling all local ports to one remote means that you can't configure applications to print to different network printers—for example, XyWrite to a redirected LPT1 and PageMaker to a redirected LPT2. You have to use GV LAN OS's "select a device" option, or run gvprint, to switch to an alternate network printer.

If you try to reboot a server that has files open, GV LAN OS complains. But you can't see a list of the open files or use the network software to close them.

GV LAN OS doesn't use a disk cache, and there's only one tunable parameter: You can dedicate a bit more DOS memory to the program. Nevertheless, GV LAN OS led the pack on our database test. Running the test locally, the server hardly degraded at all under load. It took just 12 seconds longer on average than when run in stand-alone mode. We did run into one snag. One of our tests redirects input to the DOS time command from a file containing a carriage return and a linefeed. For some strange reason, that redirection failed when we were running GV LAN OS.

The manuals that came with GV LAN OS did not mention shared CD-ROM drives, but Grapevine says that the software can do that if you are using version 2.0 of MSCDEX, Microsoft's CD-ROM driver. We had the latest version of MSCDEX, 2.1, which didn't work. Grapevine says that it will support MSCDEX 2.1 by the time you read this. GV LAN OS ran our tape backup and multipurpose tests flawlessly.

The queue manager can pause, delete, or reorder print jobs. Given access to a queue, a user can modify any job.

You can unload the network with gvunload, but that tended to lock up our workstations; Grapevine acknowledged this problem. Also, clients don't always recover properly when servers go down. Normally, the software presents a "retry, cancel" dialog box; sometimes, though, clients just hang. When the server does come back, reconnection is automatic.

GV LAN OS's mail system was more complete than most. You can designate a server that will store and forward undeliverable mail. The program can attach files to messages; edit, forward, or file messages; and send mail to groups of users. An "e-forms" facility works with message templates. When we created a telephone memo, GV LAN OS automatically filled in the From: and Date: fields each time we created a new message. One drawback is that E-mail messages aren't private; users can view and delete any message on the mail server.

Only GV LAN OS can connect a laptop computer to a network workstation's serial port. The laptop becomes a slow, but fully functional, network node. It runs the same network software as all other stations. That's a great feature that we almost missed because, like so much else in GV LAN OS, it wasn't documented. To get it to work, we eventually discovered, you have to select dual media (ARCnet and serial, in our case) when installing the software on the bridge machine. Then you install GV LAN OS again, for serial transport only, on the laptop.

Grapevine's GV LAN OS led the pack on our database test.

GV LAN OS has much to recommend it. We would have preferred a more complete command language, and we'd like see the TSR menu program run from the command line. But it turned in an excellent performance, and its full-featured mail menus and serial port connectivity set it apart from the other LANs tested.

MainLAN

MainLAN, even more than GV LAN OS, depends on menus. Once you've set up your network connections, you can unload the menus to save memory. But while GV LAN OS has a minimal command language, MainLAN offers none.

MainLAN uses more than 200K bytes of RAM on a fully configured server if you run the menu system as a TSR program, or 150K bytes if you run it as a normal program. Servers incur additional overhead—about 2K bytes—for each shared disk resource. The software does not support EMS memory, extended memory, or shadow RAM. But everything is modular, so you can subtract disk, print, or mail modules if necessary. Our three servers used between 100K bytes and 150K bytes of RAM.

To our surprise, two of MainLAN's 4-Mbps adapters failed spectacularly. Glowing resistors, followed by smoke, prompted a call to U.S. Sage. The company says—although the manual doesn't document this—that you have to connect all cabling *and terminators* before applying power. This bodes poorly for busy offices where cables can be inadvertently disconnected.

Once we'd obtained new adapters, MainLAN's diagnostic programs made testing the network adapters and twisted-pair connections a snap. The diagtest program checks six parameters, including the IRQ line and the RAM address. Then it tries to communicate with respond, which runs on another station. Each node requires a unique name and number that you set during the installation procedure.

To share a disk drive, you assign an alias to a drive and path and then attach a password and access rights (read, write, create) to it. MainLAN didn't recognize our CD-ROM as a valid drive. We couldn't share it, but we could still use it locally while running the network software.

You can view each server's shared resources, but not as conveniently as we would like. Typically, you've got to work through a series of menus to find those resources. Then you have to find the menu where you'll apply what you've learned. That's generally true of MainLAN: Information is available, but it never seems to be at hand. You constantly have to back out two or three levels and then descend along another path.

You can access remote file systems with an interesting facility called files. It bypasses normal procedure; there's no formal network connection. The files facility confers the power to browse directories and to send, retrieve, rename, or erase files—everything but delete *.*. MainLAN leaves this back door open until you shut it with netsetup. Since users typically take the defaults that come with a system, files, though useful, could be dangerous.

MainLAN's mail facility designates one machine as mail server—a place to store undeliverable messages. You can send messages, with attached text files, to groups or to everyone on the network. You cannot send binary files because MainLAN puts a header at the top of each file it sends.

MainLAN has trouble with broken connections. When we turned off a server, workstations that tried to access its shared resources hung. The same thing happened when we tried to connect to a resource before the server had shared it. MainLAN prompted us before allowing a server reboot, but we couldn't check to see if other users had files open

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Circle 286 on Reader Service Card

MAC LAN PERFORMANCE

Table 4: In both tests, a Mac Portable acted as the client machine, and a Mac SE was the server. Times are in seconds.

NETWORK FILE I/O TEST

LAN	Read	Write
TOPS	119	31
PSN	130	35

DATABASE TEST

LAN	Duration
TOPS	149
PSN	141

on a server before powering it down.

A MainLAN client can't have multiple connections to remote printers. The `divert` command redirects that connection across the network; `undivert` restores local service. MainLAN's manual recommends against using serial printers because the network can send data to a serial device at only 36 characters per second.

When you print from an application, or even from DOS itself, entries in the print queue show up only as numbers. That's inconvenient. To cancel a job, you have to open the print queue menu, note its number, back up to the previous menu, select `cancel`, and type something like "PRINTJOB 000004." Only MainLAN's own print option attaches readable names to queue entries. Queue owners, like all other users, can delete only their own print jobs. If there's a problem, the queue owner must back out of the printer submenu and go to yet another submenu, local print, to clear all print jobs from the queue.

MainLAN demonstrates how little a network adapter's throughput ratings mean in terms of actual performance. Its 4-Mbps adapters had the fastest throughput rating of the products we tested, yet MainLAN turned in one of the slowest performances on our database test. MainLAN had one setting—number of cache blocks—that improved network performance, but raising it consumed more memory than we could spare.

MainLAN did almost everything that we asked of it. But despite its ability to unload program modules, it was still quite large when configured to meet our needs. It didn't support multiple remote printers, and we seemed to hang systems too often.

The Mac Side

TOPS

Mac-to-PC connectivity sets TOPS apart from the rest. A TOPS network "feels" like a Macintosh network, whether it is made up of Macs only, PCs only, or a mixture of the two. PCs use LocalTalk interface cards; Macs use their built-in LocalTalk hardware. Both speak ALAP, the AppleTalk Link Access Protocol. An AppleTalk network runs at 230,000 bps, but with TOPS FlashCards and FlashTalk drivers, PCs can communicate with one another at triple that rate—768,000 bps. A Mac that's equipped with a TOPS FlashBox and a FlashTalk driver can also go at 768,000 bps.

FlashTalk devices conduct arbitration with communications partners to determine if they're capable of the higher speed, so there's no problem mixing AppleTalk and FlashTalk on the same cable. TOPS can also run on Ethernet cabling, which can link PCs and adapter-equipped SE- or II-class Macs. We built a six-node network: three PCs (with FlashCards), two Macs (without FlashBoxes), and an AppleTalk-connected LaserWriter.

The Mac version of TOPS 3.0 now complies with the Mac OS's "shared environment extensions." That means it supports multiuser applications—notably FoxBase and 4th Dimension—that earlier versions of TOPS didn't.

TOPS, unlike PSN, doesn't use the AppleShare client interface. Both server and client operations flow from the TOPS desk accessory (DA), which displays the volumes that a server can *publish* (share) or that a client can *mount* (use). But TOPS and the AppleShare client software that ships with the Mac can coexist happily. We had no trouble mounting Mac- and PC-resident TOPS volumes side by side with AppleShare volumes on a Mac client.

Like PSN, TOPS does something that AppleShare doesn't: It can make a Mac into a nondedicated server. To compare the two networks, we ran our file I/O and database benchmarks on a two-station Mac network. We were able to run FoxBase interactively on both stations against shared databases, but our benchmark program—which hammers on the data—hung both machines several times. (TOPS, however, has been unable to reproduce this problem.) So for the database test, we ran just one station—the client. The results were practically a dead heat. TOPS was marginally faster on the file I/O test, and PSN was just barely faster on the database test.

The TOPS spooler is another feature that AppleShare lacks. Also implemented as a DA, it captures and stores LaserWriter-destined output. The spooler works only with network printers; you cannot spool to a local, serially connected ImageWriter. Features of the spooler include the ability to delete items from the print queue, reorder the queue, hold or release the queue, and reset the LaserWriter with a specified Laser Prep file.

TOPS/DOS 3.0 improves on earlier versions of TOPS for the PC in several ways. Most notably, it can use Rational Systems' DOS/16M to load most of itself into extended memory on a 286 or 386 PC. That is critical because, although TOPS can make a PC into a file and print server, you won't have room to do much else on a 640K-byte machine.

TOPS/DOS 3.0's support for the Mac's Hierarchical File System (HFS) makes a PC server much more attractive to Mac clients. TOPS has cleaned up its act on the PC, too. Previously, PCs configured as Macintosh file servers found their hard disks littered with hidden files. TOPS/DOS 3.0 consolidates all these hidden files into hidden databases that occur just once per directory.

On the PC, TOPS presents a smorgasbord of options. There are file server, print server, file client, network printer client, remote printer client, and local printer client modules. Each loads separately and exacts its price in RAM. If you load the full set of TOPS services into low memory on a 640K-byte PC, you'll cripple it. In that configuration, TOPS consumes more than 300K bytes.

With 1 MB of extended memory to play with, it's a different story; when you load high, maximal TOPS eats only about 50K bytes of real memory. Watch out for other extended memory managers, though. On the Dell, we had been using both SMARTDRV.SYS, which is the Microsoft Windows disk cache, and QEMM, Quarterdeck's expanded memory simulator. Things worked erratically unless we threw out one or the other. Although both DOS/16M and QEMM comply with VCPI (Virtual Control Program Interface), SMARTDRV.SYS doesn't, and that may have been the problem.

A printer that is connected to a PC and shared with the network is a *remote* printer in TOPS lingo, as opposed to a *network* printer, which is a LaserWriter

continued

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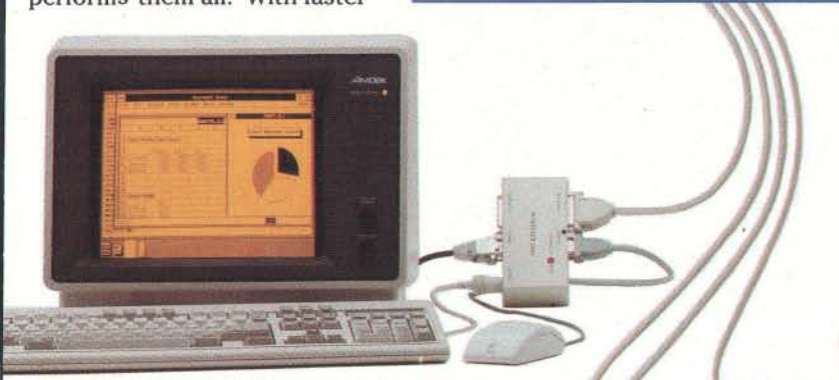

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Additional adapters: $249
Inquiry 1072.

Corvus Systems, Inc.
(ReadyNet 1.0)
160 Great Oaks Blvd.
San Jose, CA 95119
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(408) 281-4100
ReadyNet starter kit (two adapters, cabling, and software): $499
Add-On kit (card, cabling, and software): $249 per node
Inquiry 1073.

D-Link Systems, Inc.
(LANsmart 2.0)
5 Musick
Irvine, CA 92718
(714) 455-1688
LANsmart starter kit (two adapters, cable, and software): $495
Additional ARCnet cards and cable: $195
Inquiry 1074.

Fresh Technology Group
(Map Assist: $349)
1478 North Tech Blvd., Suite 101
Gilbert, AZ 85234
(602) 497-4200
Inquiry 1075.

Grapevine LAN Products, Inc.
(GV LAN OS 1.1)
15323 Northeast 90th St.
Redmond, WA 98052
(206) 869-2707
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ARCnet adapters and cable: $295
Inquiry 1076.

Information Processing Technologies, Inc.
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(818) 347-7791
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Inquiry 1077.

Invisible Software, Inc.
(Net/30 1.52)
1165 Chess Dr., Suite D
Foster City, CA 94404
(415) 570-5967
Model 200 adapter card, cable, and software: $215
Inquiry 1078.

The Lambda Group
(Pipes Drive)
555 DeHaro St.
San Francisco, CA 94107
(415) 626-4545
$395 per server
Inquiry 1079.

TOPS
(TOPS, TOPS/DOS 3.0)
950 Marina Village Pkwy.
Alameda, CA 94501
(415) 769-9669
Network Bundle for Macintosh: $299 per node
Network Bundle for DOS: $249 per node
FlashCard for PC: $239
FlashBox for Mac: $189
Inquiry 1080.

U.S. Sage, Inc.
(MainLAN 2.14)
2005 Tree Fork Lane, Suite 125
Longwood, FL 32750
(407) 331-4400
Starter pack (two adapters, software, and cable): $499
Extension pack (adapter and cable): $199
Inquiry 1081.

operating as an independent network node. You attach a remote or network printer to a client's printer port in a way that's reminiscent of the Mac's Chooser interface.

A third variety, the *local* printer, enables a client to spool to its locally attached printer and to coordinate the use of that printer with other clients that view it as a remote. Thanks to TOPS's network-oriented print services, it delivered better LaserWriter support to PCs than did most of the PC networks we tried. TOPS can even convert a PC text file to PostScript, in case you're working with an application that doesn't come with a PostScript driver.

We configured several machines as clients only, to try our database benchmark (see table 4). We were able to run the benchmark concurrently on a PC server and on several PC clients. When we added a Macintosh client, all four machines locked up. However, on the less intensive interactive test, all went well. Both PC and Mac clients were able to access and lock records stored on a PC server.

We weren't able to get a PC TOPS server to share our Hitachi CD-ROM drive. But with a Mac TOPS server, we did succeed in sharing Apple's CD-ROM drive. PSN can't do that; it fails trying to write information to the unwritable CD-ROM disk. AppleShare itself faces the same problem, but it offers a workaround: It can write to the start-up volume instead.

TOPS exhibited several annoying quirks. If you try to unpublish a volume that clients are using, TOPS will warn you, but it does nothing to catch Control-Alt-Delete on a server. TOPS won't automatically reestablish lost connections; you've got to unmount and remount a remote drive if its server goes down. Several times, we found servers and clients in disagreement as to the status of a volume and had to reboot both to clear things up.

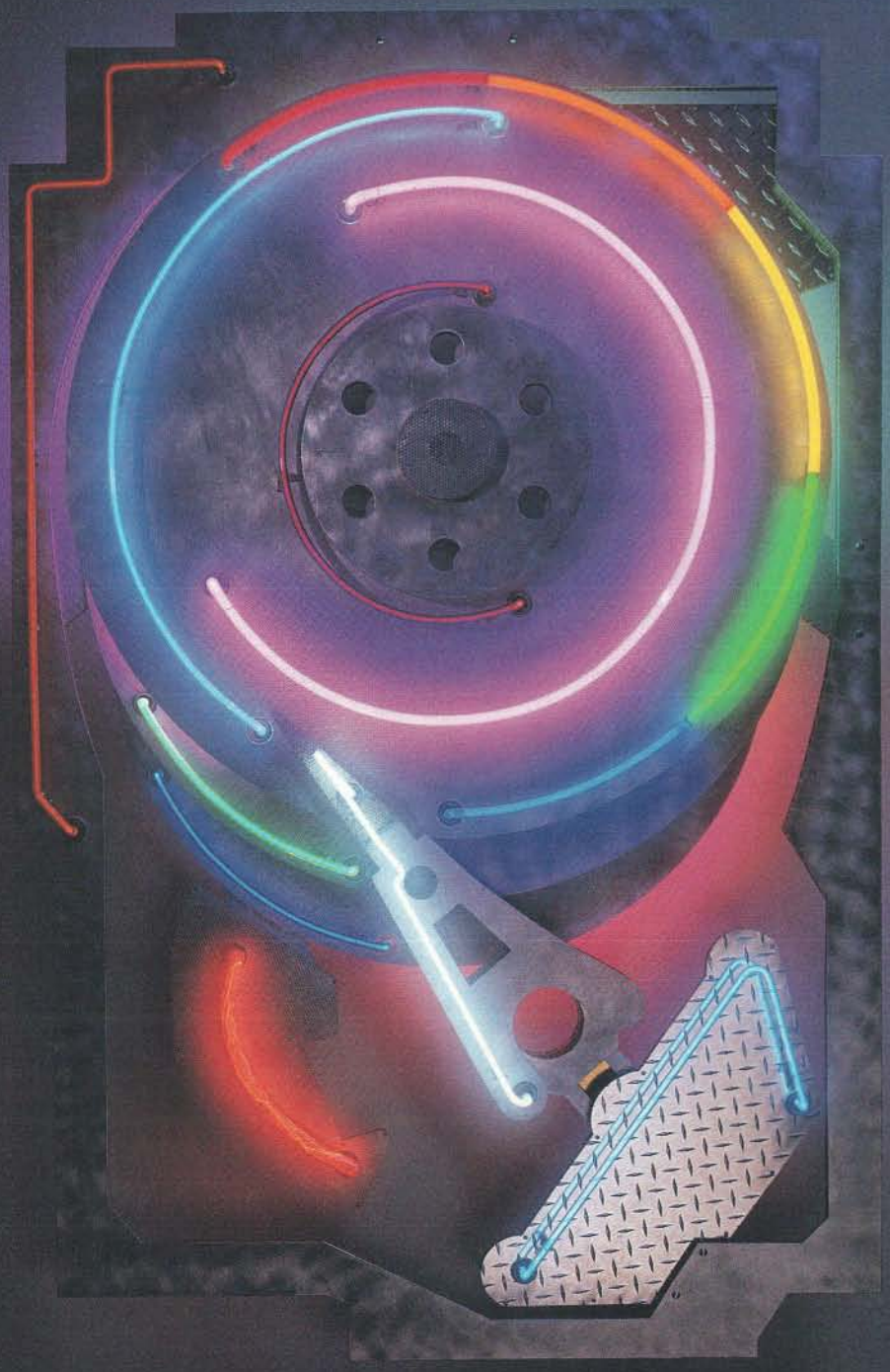
You can unload some or all of the TOPS TSR modules, but we sometimes had problems doing so. For example, the `tops unload` command won't complete if you've got a volume published. But you can't then unpublish the volume. You need the server module for that, which—catch-22—TOPS *did* manage to unload. In general, TOPS/DOS users need to know more than they may want to about what the TOPS modules are and how they interact with one another.

In the final analysis, TOPS 3.0, although greatly improved, remains a Mac-oriented solution. As such, it's outstanding. There's no cheaper or easier way to network Macs and PCs. InBox, an excellent E-mail program that's now bundled with PC and Mac versions of TOPS 3.0, adds significant value to the packages. One interesting application for

continued

Seagate's Technology

THE FINE ART OF DISC DRIVES



Neon Sculpture by
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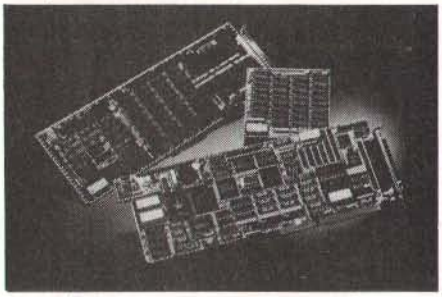

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TOPS would be to implement an inexpensive PC server for an otherwise predominantly Macintosh network. But what once was true of TOPS still is: There are better ways to build an all-PC peer network.

Personal Service Network

If the Macintosh could run AppleShare server software and ordinary applications at the same time, you wouldn't have to dedicate a whole Mac SE- or II-class machine to lowly file service. Information Processing Technologies' (IPT) PSN does the trick. We installed PSN on a Mac SE, published a hard disk, and went on a tour of the office. LocalTalk cabling connects the Mac to seven or eight other machines. Because they're all AppleShare clients, they could immediately see and mount our volume, side by side with our regular AppleShare server.

Like AppleShare, PSN uses the network client software that comes with the Macintosh. From the client's perspective, PSN servers show up in the Chooser. They coexist with and are indistinguishable from AppleShare servers.

Like TOPS, PSN creates a peer network. But while every TOPS node, client or server, costs $299, you pay for PSN servers only. PSN comes on a single disk configured for two, four, or 10 servers; corresponding prices are $289, $529, and $999. Since any number of clients can connect to each server by means of the AppleShare client software that they already own, PSN will in most cases cost a lot less than TOPS.

The PSN installer ran smoothly, although we wondered why it asked whether we'd like to modify the Mac's boot block. When we launched the server software, we discovered the answer. Weird crashes sent us back to the installer, which we used to boost the size of the Mac's system heap (and, while we were at it, bump up the maximum number of open files). It felt strange, but, let's face it, the Mac has lost its innocence. INITs, DAs, and cdevs have done to the Mac what TSR programs have done to the PC: made a mess. PSN's boot block technique, though slightly scary, guarantees a safe playground for PSN's INIT and whatever else you start up with.

We installed PSN on the same two Macs we used to test TOPS—a 1-MB Portable and a 4-MB SE. IPT recommends 2 MB of RAM for a server, but some applications—we tried MindWrite and HyperCard—can coexist with the PSN server in just 1 MB. As with TOPS, applications multitask acceptably with the server. During times of moderate to heavy network use, screen updates become jerky, and applications must often wait for the disk.

Still, everything worked. In fact, PSN, unlike TOPS, successfully ran our database test concurrently on a server and a client. That may have been a result of what IPT calls "loopback mode." When you start up a PSN server, the software logs you onto your own machine. Because the network software handles both local and remote disk access, it can ensure that the two processes mesh gracefully.

If you've worked with the AppleShare server software, you'll feel right at home with PSN. You can grant users the same privileges: "see folders," "see files," and "make changes." Administration of a PSN server is straightforward and uncomplicated.

PSN doesn't do spooled printing or E-mail, as TOPS does. But if you need a Mac file server and cannot spare a Mac, check this product out. It's a real gem. If a forthcoming PC version of PSN pans out, TOPS could face some serious competition.

The Final Analysis

Every vendor claims that its network is easy to use. In most cases that's true, once you've plowed through setup and configuration. But successful networking—particularly peer networking—requires thought and effort. All these products should acknowledge that and provide task-oriented documentation. Only TOPS, in its Applications Compatibility Supplement, does this thoroughly. We'd like to see a lot less clamor about "ease of use" and a lot more practical advice detailing when, why, and how to apply the tools provided.

Of the PC-only networks, we recommend LANtastic, Net/30, and GV LAN OS, in that order. LANtastic is clearly the best bet for the 640K-byte-and-under crowd; it's also a solid all-around performer. So is Net/30, which quietly handled everything that we asked it to do. GV LAN OS, newly incarnated on ARCnet, runs fast, offers the best E-mail system, and supports laptop connectivity. On the Mac side, we recommend both TOPS and PSN, for different reasons: TOPS to connect Macs and PCs, and PSN for all-Mac, AppleShare-compatible networks. ■

Jon Udell is a BYTE senior editor at large. Rob Mitchell is a BYTE technical editor. They can be contacted on BIX as "judell" and "rob_mitchell," respectively.

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REVIEWS

SYSTEM

Mark L. Van Name and Bill Catchings

REVIEW

Two to Grow On

The ALR PowerFlex (top) and AST Premium 386SX/16, with processor modules.

With most personal computers, to get a faster CPU you must replace either the motherboard or the entire system. Two vendors, Advanced Logic Research (ALR) and AST Research, offer systems that let you upgrade their CPUs as your wallet permits. While the two companies offer similar CPU options, their approaches to the CPU upgrade problem are very different.

ALR's PowerFlex gives you a relatively cheap path to a 486. The $1495 base system, the Model 40, starts with a 12.5-MHz 286 CPU on the motherboard, a socket for either an 8-MHz 80287 or a 12.5-MHz 80C287A math coprocessor, 1 megabyte of memory, a 3½-inch 1.44-MB floppy disk drive, a 40-MB hard disk drive, a serial port, a parallel port, a disk of system utilities, and a keyboard. All you need to get going is a video adapter (ALR's VGA card, which adds a second parallel port, costs $329), a monitor (ALR's VGA monitor costs $499), and DOS (MS-DOS 3.3 is $85 from ALR). Our evaluation system included these extras and an additional 4 MB of memory ($796), for a total tab of $3204.

The 286 system is just the starting point. You can step up to a 16-MHz 386SX with the $395 PowerFlex 386SX module, or you can choose a 25-MHz 486 with the $1995 PowerFlex i486 module. Our fully equipped evaluation system with the 386SX CPU ran $3599, $5199 with the i486—pretty inexpensive for a complete 486 system with 5 MB of memory. If you purchased a 386SX module, ALR will refund your $395 when you purchase the i486 module.

AST's upgradable offerings cost quite a bit more—but they're also much faster. The base Premium 386SX/16 system costs $2695, for which you get a 16-MHz 386SX, a socket for a 16-MHz 80387SX coprocessor, 1 MB of memory (expandable to 4 MB), 16K bytes of 35-nanosecond static RAM (SRAM) cache managed by an Intel 82385SX cache controller, your choice of either a 5¼-inch 1.2-MB or a 3½-inch 1.44-MB floppy disk drive, an AST VGA graphics adapter, two serial ports, one parallel port, a disk of system utilities, and a keyboard.

To construct a system comparable to the ALR PowerFlex 386SX configuration, you'd also need a VGA monitor (AST's is $695), a 40-MB hard disk drive ($700 from AST), MS-DOS 3.3 ($95 from AST), and an additional 3 MB of memory ($900). That system costs $5085—$1486 more than the comparable ALR unit. (Our review system included a total of 8 MB of RAM, raising the price by $1700.)

To upgrade this AST system to a 25-MHz i486 CPU, you just buy an AST Fastboard 486/25 and replace the 386SX processor card with the new card. The Fastboard 486/25, which includes 4 MB of RAM, lists for $6395, but when you send AST your 386SX card, the company credits you 35 percent of the list price of the i486 card. Thus, you actually shell out $4157 for the i486 card. That brings our comparison 486 system's price to $8342—over $3000 more than the comparable PowerFlex.

Photo 1: *The compact PowerFlex CPU cards don't include on-board RAM; both the 386SX and i486 modules access motherboard memory through an AT bus. This design restricts the i486 module's performance but lets ALR price the i486 more aggressively.*

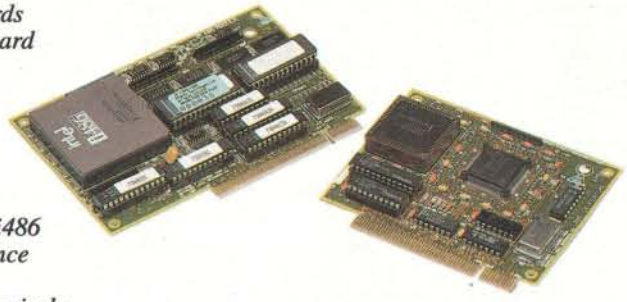
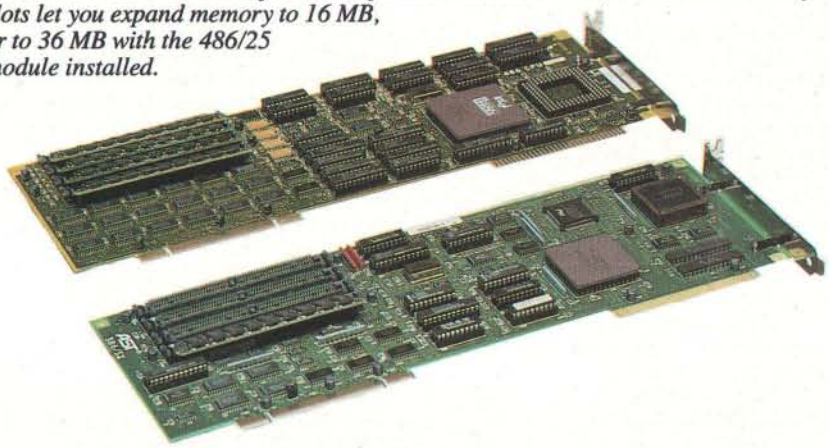


Photo 2: *The Premium 386SX/16's proprietary 32-bit memory architecture gives its processor cards a performance edge over ALR's PowerFlex, but at a much greater price. Each card has room for 4 MB of SIMM-mounted RAM; additional memory slots let you expand memory to 16 MB, or to 36 MB with the 486/25 module installed.*



Price Isn't the Only Thing

If all you consider is price, then ALR's PowerFlex is the clear winner. But don't judge on price alone; you should also consider performance. That's where the AST systems shine. The AST Premium 386SX/16 beats the PowerFlex 386SX by about 14 percent on BYTE's overall application index. Moving up to the i486 CPU in both machines, the Premium wins on the overall application index by 42 percent (see the table and figure).

If the PowerFlex wins on price and the Premium wins on overall performance, it's natural to wonder which computer wins on price/performance, that much-abused industry-staple catchphrase. Comparing 486 systems, the Premium costs about 60 percent more than the PowerFlex but delivers 42 percent better overall performance—so the PowerFlex has the better price/performance ratio. If you compare 386SX systems, the Premium costs about 41 percent more than the PowerFlex but delivers only about 14 percent better overall performance—so the PowerFlex once again gets the price/performance nod.

Still, we think that comparing these two systems is something of a mug's game. They're clearly oriented differently—the Premium toward high performance at high prices, and the PowerFlex toward modest prices with similarly modest performance. The dissimilar architectures of these two machines support this claim.

The PowerFlex is basically a midrange 286 with a way to upgrade the CPU grafted onto it. The motherboard uses four of the five standard Chips & Technologies NEAT (New Enhanced AT) application-specific integrated circuits; it's missing only the optional C&T EMS mapper. All the memory goes on the motherboard, which uses the interleaving architecture of the C&T memory interleave controller ASIC to avoid wait states. The base 1 MB on the motherboard is in 256K-byte, 80-ns single in-line memory modules. You can add only 4 MB more, courtesy of four SIMM sockets on the motherboard that can hold 1-MB or 256K-byte SIMMs. Because of the interleaved memory architecture, you must add SIMMs in pairs. All memory is on the AT-style bus on the motherboard.

While the 386SX is designed to work with a standard AT bus, you really pay for that slow bus when you install the i486—hence the ALR system's relatively poor i486 performance. Both the 386SX and the i486 processor modules use the memory on the motherboard; neither has its own memory. The 386SX module has a socket for an 80387SX coprocessor, while the i486 module relies on the math coprocessor built into the i486 chip.

Both processor modules are small and easy to install (see photo 1). You just plug the card into a special feature connector on the motherboard, and you're in business. You don't have to mess with any DIP switches or software setup options.

The AST processor cards are also easy to install, but that's where the similarity between the internals of these two machines ends (see photo 2). The Premium 386SX/16 is a member of AST's CUPID (Completely Universal Processor and I/O Design) line of systems. AST designed the CUPID systems to be both expandable and fast. Consequently, all the system memory and CPU support is on processor cards designed to run at full speed.

The CUPID motherboard itself provides all the basic system services aside from CPU and memory. It contains a Western Digital floppy disk drive controller chip, as well as chips that support IDE (Integrated Device Electronics; AST prefers the term *AT-embedded*) hard disk drives and the I/O ports.

All the interesting action is on the processor cards, which are full-length expansion cards that can plug into any of the three proprietary 16-/32-bit slots on the motherboard. These slots have a proprietary extended connector near the

continued

PowerFlex Model 40

Company
Advanced Logic Research, Inc.
9401 Jeronimo
Irvine, CA 92718
(714) 581-6770

Components
Processor: 12.5-MHz 286 with socket for 8-MHz Intel 80287 or 12.5-MHz 80C287A FPU on motherboard; 16-MHz Intel 386SX and socket for 16-MHz Intel 80387SX FPU on the 386SX upgrade module; 25-MHz Intel i486 on the i486 upgrade module
Memory: 1 MB of 80-ns DRAM in 256K-byte DIPs on motherboard, expandable to 5 MB on motherboard using 1-MB SIMMs
Mass storage: 3½-inch 1.44-MB Teac floppy disk drive; 40-MB 28-ms 3½-inch Western Digital IDE hard disk drive
Display: Optional Nanao FlexScan 8060H multisync monitor
Keyboard: 101-key modified IBM Enhanced AT layout
I/O interfaces: 25-pin serial port; two 25-pin parallel ports; one 8-bit and five 16-bit expansion slots (five open)

Price
Base system: $1495
As tested with the PowerFlex 386SX module: $3599
As tested with the PowerFlex i486 module: $5199

Inquiry 854.

Premium 386SX/16 and 486/25

Company
AST Research, Inc.
16215 Alton Pkwy.
Irvine, CA 92718
(714) 727-4141

Components
Processor: 16-MHz Intel 386SX and socket for 16-MHz Intel 80387SX FPU on 386SX/16 processor card; 25-MHz Intel i486 with socket for 25-MHz Weitek WTL4167 FPU on the 486/25 processor card
Memory: 1 MB of 80-ns DRAM in one 1-MB SIMM on the 386SX/16 processor card; 16K-byte 35-ns SRAM cache; 4 MB of 80-ns DRAM in four 1-MB SIMMs on the 486/25 processor card, expandable to 16 MB for the 386SX/16 and to 36 MB for the 486/25 using 1-MB SIMMs on the processor cards (up to 4 MB) and on optional memory-expansion cards
Mass storage: 5¼-inch 1.2-MB Teac floppy disk drive; 40-MB 28-ms Conner Peripherals IDE hard disk drive
Display: AST Premium Display/VGA 13-inch VGA monitor
Keyboard: 101-key IBM Enhanced AT keyboard layout
I/O interfaces: Two 25-pin serial ports; one 25-pin parallel port; one 8-bit and six 16-bit AT-style expansion slots (five open; three 16-bit slots have extended connectors that accept a processor or memory card)

Price
Base system: $2695
As tested with the 386SX/16 processor card: $6785
As tested with the 486/25 processor card: $10,041.75

Inquiry 855.

front of the unit and a standard AT-style 16-bit expansion slot near the rear, so you can also use any empty slots for normal expansion cards. As with the ALR processor modules, you can just plug in these cards and get to work; the system recognizes which processor you're using without any effort on your part.

The i486 processor card relies on the SRAM cache and cache controller in the i486, but there's a socket for a Weitek WTL4167 coprocessor if you want to increase your floating-point performance. The card comes standard with 4 MB of memory in four 1-MB 80-ns SIMMs, which supports the 32-bit burst-mode memory transfers of the i486. This card does a good enough job that the Premium 486/25 beat by 4 percent the overall application index of the Dolch-P.A.C. 486-25 portable, the only other shipping i486 system BYTE has benchmarked.

In keeping with the high-performance orientation of these CUPID systems, and unlike the ALR systems, you are not limited to the 4 MB of memory on the processor cards. You can add memory by buying an $800 AST memory-expansion card that, like the processor cards, plugs into the proprietary system connectors; thus, the CPU has a full 32-bit path to all system memory. Each memory-expansion card can hold up to 16 MB in 16 1-MB SIMMs; the three proprietary system connectors give you room for two such cards. With two memory-expansion cards, therefore, you could configure a Premium 486/25 with 36 MB.

Getting Along

With all these CPU options, we were wondering if we'd have compatibility problems, so we ran our full test suite of around two dozen programs and several hardware options on both AST processor cards and all three ALR CPU configurations. Both AST processor options successfully ran every program we threw at them, and they worked with all our test hardware.

The three ALR processor options were almost as successful. We uncovered only one tiny problem: When we tested Digitalk's Smalltalk/V 1.2 with a Microsoft mouse driver loaded after NetWare was up and running, all three ALR CPU configurations caused a short beep when we pressed both mouse buttons to summon Smalltalk's menus. The menus still appeared, however, so this is not a big problem. An ALR spokesperson said that the company was not familiar with this problem, but that it would investigate and fix it.

The Rest of the Story

Aside from their array of CPU options, both systems are fairly standard PC compatibles. Both use 3½-inch 40-MB, 1-to-1 interleave, 28-millisecond IDE hard disk drives—a Western Digital drive in the ALR PowerFlex and a Conner Peripherals drive in the AST Premium. Both vendors offer VGA monitors and 16-bit VGA cards. Both keyboards are reasonable, although the Premium's exactly follows the IBM Enhanced AT keyboard layout, while the PowerFlex's modifies that layout with the common fat Enter key.

The machines even have similar expansion options, although the Premium wins on drive bays: With the 40-MB hard disk drives in both systems, the Premium has three open 5¼-inch half-height bays to the PowerFlex's two. The PowerFlex has six expansion slots, five 16-bit and one 8-bit; one 16-bit slot holds the video card, and the other slots are open. The Premium has seven expansion slots, one 8-bit and six 16-bit; three of the 16-bit slots have the proprietary extended connector. With processor and video cards, the Premium has five open slots, just like the PowerFlex.

Both units come with system manuals, but here the Premium is way ahead of the PowerFlex. The PowerFlex's small manual tells you what you need to get going with the system, but little more. The Premium's manual is far larger and more comprehensive.

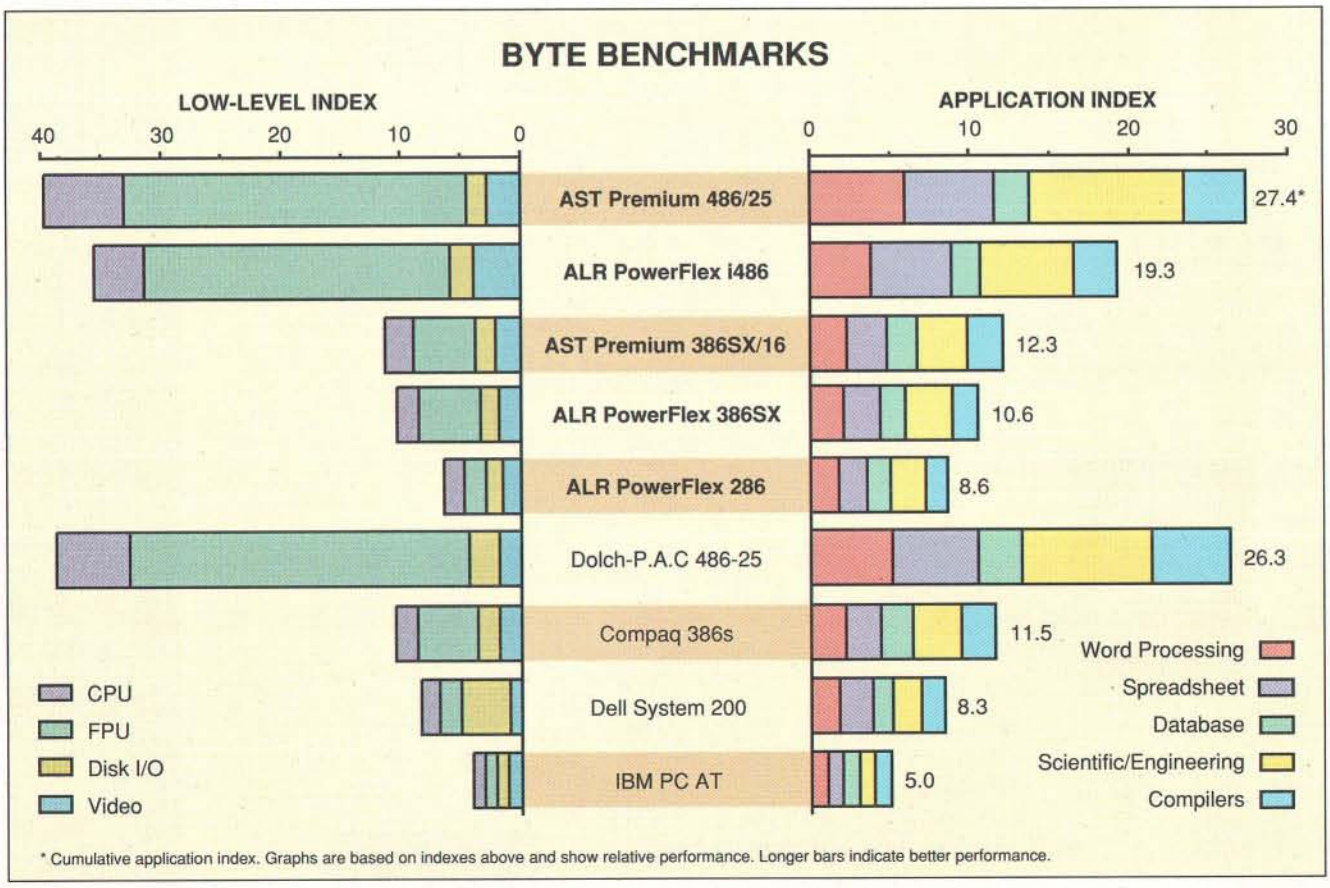
On the service side, both vendors offer a one-year parts-and-labor warranty,

BYTE BENCHMARK INDEXES

The BYTE indexes show the AST Premium's performance edge over the ALR PowerFlex. We've included other systems in the table for comparison. (We did not run the full BYTE benchmark table due to space limitations.)

	LOW-LEVEL				APPLICATIONS					CUM. APP. INDEX
	CPU	FPU	Disk I/O	Video	Word processing	Spreadsheet	Database	Scientific/ engineering	Compiler	
AST Premium 486/25	6.75	28.46	1.78	2.77	5.93	5.58	2.21	9.81	3.83	27.36
ALR PowerFlex i486	4.25	25.47	1.88	3.87	3.90	4.97	1.81	5.89	2.69	19.26
Dolch-P.A.C. 486-25	6.20	28.20	2.48	1.81	5.18	5.35	2.68	8.15	4.94	26.30
AST Premium 386SX	2.36	5.17	1.70	2.06	2.36	2.47	1.85	3.21	2.14	12.03
ALR PowerFlex 386SX	1.80	5.14	1.63	1.79	2.09	2.27	1.60	2.93	1.65	10.55
Compaq 386s	1.86	5.03	1.78	1.87	2.24	2.15	2.06	3.01	2.05	11.51
ALR PowerFlex 286	1.66	1.88	1.38	1.51	1.83	1.73	1.52	2.14	1.43	8.65
Dell System 200	1.60	1.72	4.05	1.09	1.83	2.01	1.31	1.74	1.46	8.34

Note: Benchmark table includes index numbers only; full benchmark results are available on request. All results are indexed to show relative performance; for all indexes, an 8-MHz IBM PC AT = 1. For a full description of all the benchmarks, see "Introducing the New BYTE Benchmarks," June 1988 BYTE.



* Cumulative application index. Graphs are based on indexes above and show relative performance. Longer bars indicate better performance.

with your dealer as the first line of support. ALR also offers on-site service from Intel for an additional fee.

If you need a PC that combines a CPU upgrade option with excellent performance, and if you've got the bucks to pay for that combination, go with the AST Premium. If you want to be able to move to the 386SX or i486 world someday, but you're on a budget and willing to sacrifice some performance, choose the ALR PowerFlex. ■

Mark L. Van Name and Bill Catchings are BYTE contributing editors. Both are also independent computer consultants and freelance writers based in Raleigh, North Carolina. You can reach them on BIX as "mvanname" and "wbc3," respectively.

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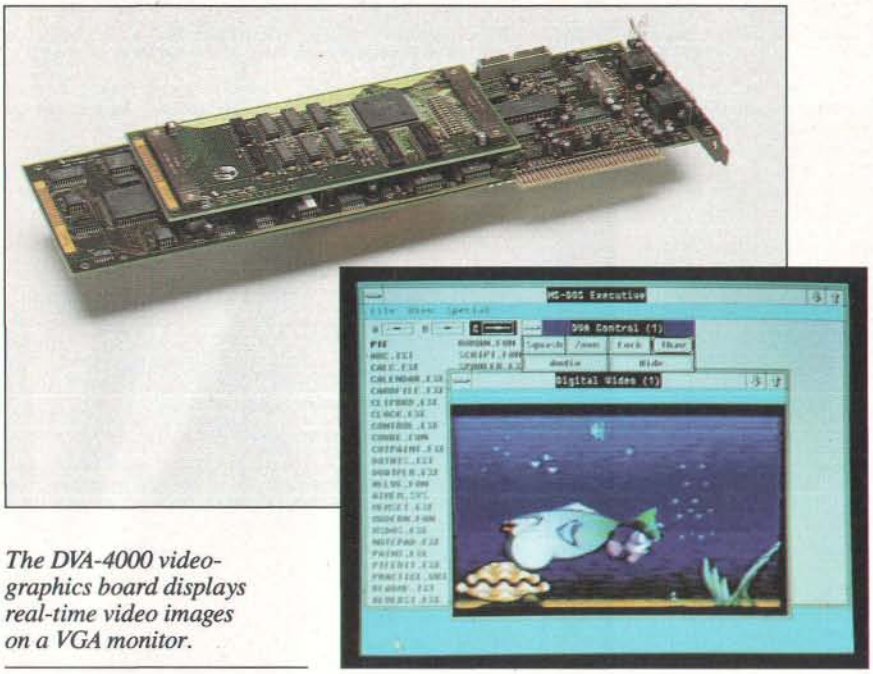
Circle 82 on Reader Service Card

Greg Loveria

REVIEW

Window Wonderland



The DVA-4000 video-graphics board displays real-time video images on a VGA monitor.

For years I've mused about the possibilities of simultaneously displaying live video and standard applications on my VGA monitor. Recently, my musing turned to contentment, thanks to Digital Video Architecture (DVA) from VideoLogic.

The DVA-4000 video-graphics board displays clear, crisp, real-time images of National Television System Committee (or phase alternate line) video signals within resizable "smart windows" on VGA monitors in 640- by 480-pixel, 16-color mode. The windows let you freeze a video image or change complete color palettes in the scenes you're viewing.

The DVA-4000 converts real-time analog video signals from TVs, VCRs, or laser disks into digital pulses—no small feat in itself—at a speed of 25 million bps (see the figure). At the core of these conversions is VideoLogic's DVA chip set, with some chips working as the equivalent of a 68000 CPU. The conversions work in much the same way that a compact disk player turns binary data into analog sound, but in reverse and using real-time video at 30 frames per second. The system also processes stereo audio signals from the video source to give you the equivalent of a full-fledged TV and a computer in one display. XT users take note: All this wizardry is from a single 8-bit bus card.

VideoLogic's Multimedia Interactive Control software controls how the board displays the video window, as well as all laser disk player motion commands. Simple commands can be sent to the DVA-4000 at the DOS prompt or through batch files via DOS redirection. For example, ECHO EJECT > MIC causes the videodisk player drawer to open. Likewise, commands such as VPOS (to position the video window), FADE (to fade the video in or out), and TRANSCOLOR (which makes a color transparent in the video) all work well. With the MIC software loaded, the DVA-4000 is software-accessible in the same manner as I/O devices like the printing and communications ports and the console. This essential software is a $150 addition to the DVA-4000's $2495 price tag. (You'll also need a $95 auxiliary input connector to run a second video window in either Windows or non-Windows applications.)

"Live Action" Applications

The DVA-4000 provides exciting application possibilities. Stockbrokers might use it to retrieve Dow Jones information from a telephone feed in one window, while viewing financial news programs from cable TV in another window (or two).

Working with the board's display section, a frame-accurate videodisk control system allows you to precisely control what images are displayed. If you enter the keyboard command STILL 1000, the player displays and pauses with video frame 1000 in the video window. The command STEP 20,200 / R will step 20 video frames backward from the current frame, displaying each stepped frame in 2-second intervals. This capability accommodates interactive video applications, including "live action" courseware. Students could use their computers to browse through topics of interest, enter a selection, and watch as the DVA-4000 outputs both real-time video and audio from the videodisk. You can manipulate, search, and display full-motion TV images on the VGA display as easily as working with your favorite database or spreadsheet software.

Strange Karma

The DVA-4000 works on PS/2 Micro Channel architecture and 8-bit Industry Standard Architecture buses (I evaluated the ISA version). A Macintosh board is currently being developed. The DVA-4000 is a full-length card that's configured with a top-mount daughterboard that carries the main VLSI video processor chip. The daughterboard was mounted a half-inch off the main board for proper airflow.

My first evaluation board succumbed to some strange karma. After two days, its output started flickering, and eventually the display became too dim to read. A second DVA-4000 fared better. I tested it with an Associates Computer Supply 25-MHz 386 tower unit with 8 megabytes of RAM. Only the 640K-byte base memory was available to the MIC driver software. I ran a Relisys RE-5155 multisync VGA monitor, which I also use with a TARGA board (in RGB mode) for imaging and animation.

The single-slot board's installation is easy; no jumpers need to be repositioned. A ribbon cable connects the DVA-4000 to the feature bus of the existing VGA card. This permits the DVA-4000 to work with your VGA card and allows the card to mix digital video signals into VGA analog output. Actual VGA display circuitry is not part of the card. I used the furnished serial output control cable to connect the videodisk player's RS-232C motion-control port to COM2 on the system. Not all videodisk systems are capable of being controlled in this manner. I used a Sony LDP-1550 player, which is both a constant angular velocity and a constant linear velocity unit (straight CLV machines cannot be used in this

continued

VIDEO IMAGE COURTESY OF AUTODESK, INC.

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Company
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Software Needed
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Price
$2495

Inquiry 851.

application). When connected to the computer, the player's manual motion controls are inoperative until you load the driver software.

I had to perform some creative cable patchwork before I could send input to the board from my VCR's "video out" port. But first I purchased a female RCA stereo to female BNC adapter and a 12-foot shielded video cable. I also picked up a pair of Walkman-style headphones because the audio output cable only accepts a ⅛-inch stereo miniplug.

Installing the MIC software was confusing. You can easily get lost in the software manual—the installation guidelines don't appear until almost 60 pages into it. The manual mentions previously released VideoLogic boards, but not the DVA-4000. However, if you follow the instructions (disregarding the incorrect board descriptions), the installation does work.

Batman Meets VGA

With almost every Microsoft Windows application opened and running, the full-motion video from the VCR (*Batman*) was as impressive as the images from the videodisk player. Color clarity and resolution were visibly better than the images on my 21-inch Zenith TV, which displayed the same videotape. The slightest delay separated the TV's and the VGA monitor's images. I noticed no flicker or jumpiness. All motion appeared fluid and smooth, and in real time.

The superb resolution stems from the DVA-4000's line-doubling of the 512-line signal. Conceivably, you could scale your video window to 1050- by 1050-pixel resolution. I set the multisync monitor to PS/2 mode and ran my applications in 640- by 480-pixel by 16-color resolution, while the video window actually displayed full video using a 16-million-color palette. By shrinking and stretching the window, I created strange aspect ratios, where people were either extremely tall and thin or short and fat.

I easily eyeballed correct aspect ratios by grabbing the scaling handles in the bottom-right corner of the video window. Figures inside a window that were stretched to full-screen size looked correctly proportioned. Best of all, I could shrink the video window to a Windows applications icon. Although only a half-inch square, the image in the live-video icon was clearly visible.

When I viewed still frames in the VCR pause mode, the board had problems with signal genlocking (i.e., synchronizing two video devices). This caused the picture to jump and tear at times. Still frames viewed from the videodisk were rock solid. The degradation probably resulted from the viewing media (tape versus disk) and my aging VCR.

I enjoyed a demonstration file called DVA1PLR.EXE, which runs under Windows. I opened dual video windows with the same live video input in each, except that in one window I clicked on the ZOOM function. In that window I could freeze and "thaw" movement at will. The FREEZE command did not write a "frame-grabbed" file. At press time, VideoLogic planned to release a conversion utility that would frame-grab a scene and convert the image to CompuServe's GIF and other popular formats.

Script Writer

Included with the MIC package is Applications Management System (AMS) software, which offers a simple point-and-shoot menu interface. This package lets you create and save scripts that load your programs and specify where the video window will open inside your application. This is probably one of the most important aspects of the DVA-4000.

But my thrill over being able to watch a newscast on my VGA display while working on this review was tempered at first, because I could only use Windows Write. I had problems loading and executing WordPerfect 5.0 under AMS in a 640K-byte environment. When building my loader macro scripts under AMS, I was incorrectly reinstalling the MIC driver software, causing WordPerfect to give me a "not enough memory" error. I didn't realize that AMS loads (and unloads) the driver software between applications. With the MIC software loaded, the application program memory available is only 394K bytes.

Since WordPerfect loads and executes in 384K bytes of memory, having that one extra TSR program loaded can cause program failure when calling WordPerfect from an AMS script. I spent a long evening of experimentation before getting WordPerfect to work correctly. Other, smaller applications, such as XTGold and the Norton Utilities, ran fine. AMS works, but it may not be easy for those who are short of time or patience and working with applications requiring extra memory.

I also looked at Tool Box Plus, a handy pop-up macro and ASCII editor program that works from the DOS prompt as a TSR. Alt-Shift invokes a command-line window for direct control of all MIC commands (including palette and motion) without the need to ECHO or PIPE your output to the board as with the MIC

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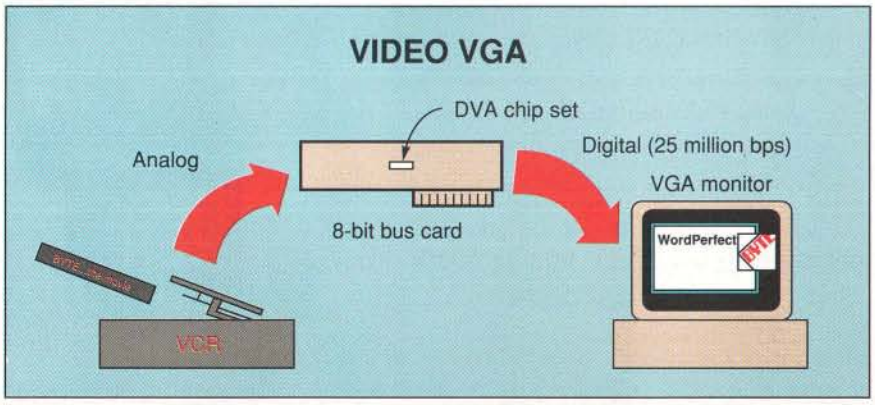

A ribbon cable connects the DVA-4000 to the feature bus of the existing VGA card. "Smart windows" can then display real-time video images and allow you to freeze, resize, and change colors in individual frames.

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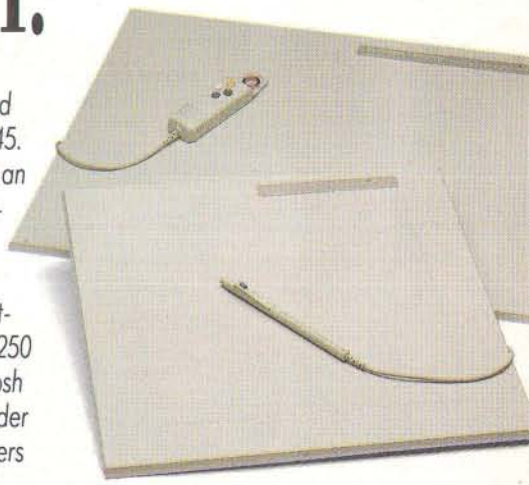

PC MAGAZINE EDITORS' CHOICE
November 28, 1989
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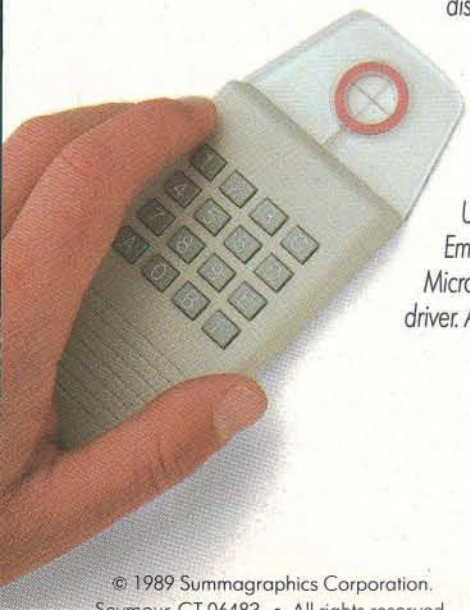

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program. After executing (or modifying) these commands, you simply press Escape to resume working (and watching) inside your application. I preferred to open video windows inside my applications with this program instead of AMS. VideoLogic's Tool Box Plus is an additional $195.

Patience Rewarded

To establish the DVA chip set as a multimedia standard, VideoLogic is aggressively cultivating third-party programmers and developers. In contrast to IBM and Intel, which distribute the Digital Video Interactive developer's kit for a price of $16,000, VideoLogic supplies free DVA-4000 and MIC "extended-loan" development packages to programmers and developers.

Aside from my strong recommendation to clarify the confusing documentation, I'd rate the DVA-4000 and its MIC software overall as a superior product in concept and design.

The DVA-4000/MIC system requires levels of patience and programming abilities to implement successfully. I would like to see a lower-priced version of the DVA-4000, possibly without the RS-232C laser disk control. Forgoing some of these features could take this product out of the niche market and into the reach of mainstream users and applications. Either way, in the not-too-distant future, I wouldn't be surprised to see the folks at VideoLogic receive an Emmy Award for "Excellence in the Television Technologies." ■

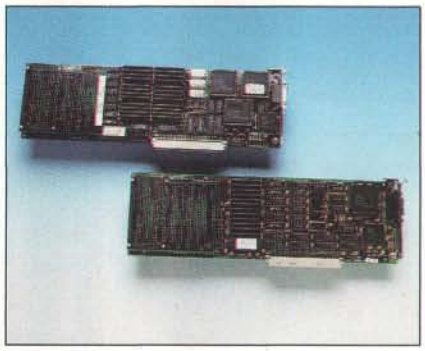
Greg Loveria is a computer graphics and desktop publishing consultant, animator, and technical writer in Binghamton, New York. He can be reached on BIX c/o "editors."

HARDWARE

Tom Thompson

REVIEW

More 16-Million-Color Fireworks



SuperMac Technology's two new NuBus video boards for the Macintosh offer on-board graphics accelerators that overcome the agonizing delays in most 24-bit-color boards displaying 16.8 million colors.

The ColorCard/24 ($999; the accelerator module is a $499 option) and the Spectrum/24 Series III ($4499) aren't the first video boards to optimize screen performance (see "How to Put 16 Million Colors to Work," December 1989 BYTE). But they are the first to offer integrated accelerator logic on-board.

SuperMac boosts display performance by minimizing image-data traffic from the Mac's main memory to the NuBus, where the video board's frame buffer lives. The company accomplished this by patching QuickDraw so that many graphics primitives became simple commands rather than a stream of pixels. On the Spectrum/24, a sophisticated state engine receives these commands and manipulates the contents of the frame buffer directly. This minimizes delays because the accelerator doesn't have to arbitrate for bus access before it operates on the frame buffer.

The ColorCard/24 provides a 640- by 480-pixel display suitable for Apple's 13-inch AppleColor RGB or 12-inch gray-scale monitors. The Spectrum/24 has two oscillators that drive 19-inch 1024- by 768-pixel monitors with either 60- or 75-Hz refresh rates. A third oscillator lets the Spectrum/24 support the same monitors that the ColorCard/24 handles. Both boards have user-adjustable screen depths of 1, 2, 4, 8, and 24 bits, and a spare socket for an optional oscillator to drive a National Television System Committee or phase-alternate-line monitor.

I ran the two boards on a Mac II running System 6.0.3 with 5 megabytes of RAM, an external Rodime Cobra 210e hard disk drive, a 13-inch AppleColor monitor, and a 19-inch SuperMac monitor. Installation was plug-and-play. Aldus FreeHand 2.0, Adobe Illustrator 1.9.3, PixelPaint Professional, and PageMaker 3.0 worked flawlessly. My usual army of INITs, FKEYs, and development software caused no crashes. TMON 2.8.3, which now provides 32-bit

continued

QUICKER ON THE DRAW

Thanks to graphics accelerators, some tasks that ran in 24-bit mode surpassed 8-bit-mode speeds. Times are in seconds, in the format accelerated/unaccelerated.

	ColorCard/24	Spectrum/24	DirectColor/24
Scroll within two-page PageMaker document, 24-bit mode			
Scroll left	133/171	76/111	59/85
Scroll right	188/248	73/121	109/118
Scroll down	72/105	50/85	27/42
Scroll up	83/116	64/105	33/51
Scroll within 5K-byte MacWrite 5.0 document			
24-bit mode	10/54	11/68	16/62
8-bit mode	NA/16	NA/20	NA/18
Scroll 200-dpi 16-bit scanned image			
24-bit mode	7/28	5/26	5/17
8-bit mode	NA/16	NA/11	NA/8

Notes: Each board ran on a Mac II with 5 MB of RAM and System 6.0.3. The ColorCard/24 drove a 640- by 480-pixel AppleColor 13-inch monitor, the Spectrum/24 drove a 19-inch 1024- by 768-pixel SuperMac monitor, and the DirectColor/24 drove a 19-inch 1152- by 882-pixel Radius monitor. None of the boards accelerates 8-bit-mode drawing operations. NA = Not applicable.

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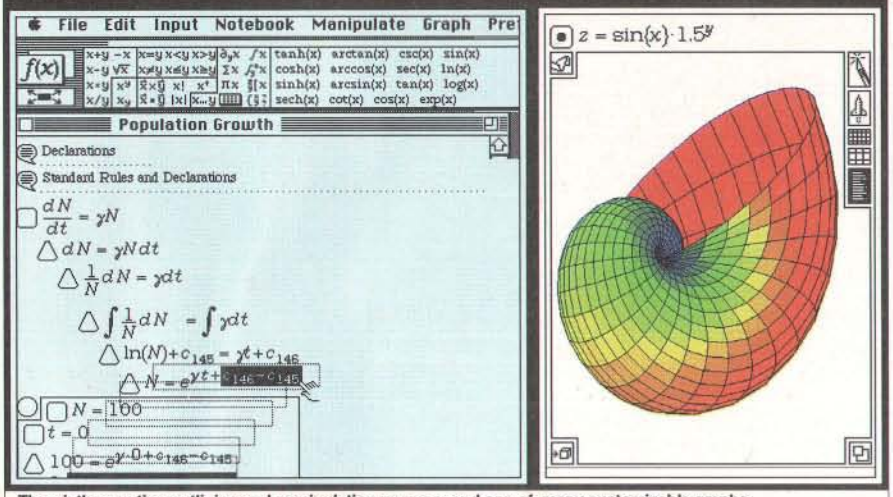

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REVIEW

Spectrum/24 Series III and ColorCard/24

Company
SuperMac Technology
485 Potrero Ave.
Sunnyvale, CA 94086
(408) 245-2202

Hardware Needed
Mac II-family computer

Software Needed
System 6.0.3 or higher; 32-Bit QuickDraw needed for viewing 16.8 million colors

Price
Spectrum/24 Series III: $4499
ColorCard/24: $999
Graphics accelerator module for ColorCard/24: $499

Inquiry 860.

display support, also worked fine.

To qualitatively compare the SuperMac boards with a Radius QuickColor accelerator working with a Radius DirectColor/24 board, I constructed a 4-MB PageMaker document loaded with text and 24-bit-deep scanned images. I also timed how long it took to scroll through a 5K-byte MacWrite document and through a 16-bit-deep 200-dot-per-inch scanned image in Adobe Photoshop 1.0b6 (see the table). Since the boards drove different-size monitors, these numbers don't tell which accelerator is faster. But you can draw two conclusions: First, the bigger the monitor, the faster you can work, simply because more of the document is on-screen. Second, acceleration is worth the extra expense. The SuperMac and Radius displays operated faster in their accelerated 24-bit modes than in 8-bit mode.

The SuperMac boards' display acceleration was so impressive that I often couldn't tell by speed alone whether I was in 8- or 24-bit mode while I wrote text or connected to a BBS. Graphics was an exception: In the 24-bit mode, the superior quality of a scanned image or shaded illustration leaped out at me. At $999, the ColorCard/24 is a bargain, but I wouldn't hesitate to spend the extra cash for the accelerator module. For those with big screens and little time, the Spectrum/24 Series III is an excellent choice. ■

Tom Thompson is a BYTE senior editor at large. You can reach him on BIX as "tom_thompson."

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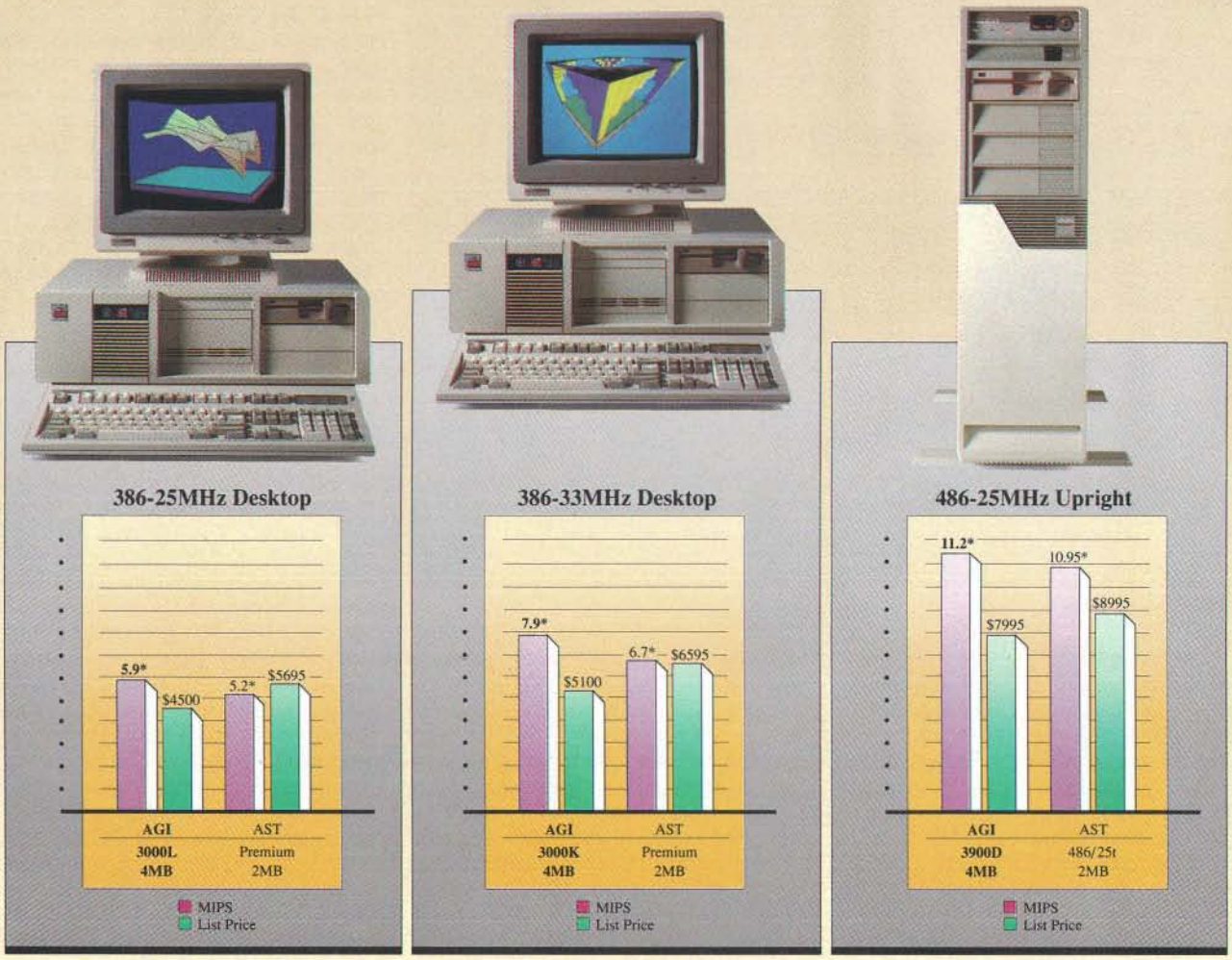

Sources: * Power Meter MIPs Version 1.5, The Database Group, Inc.

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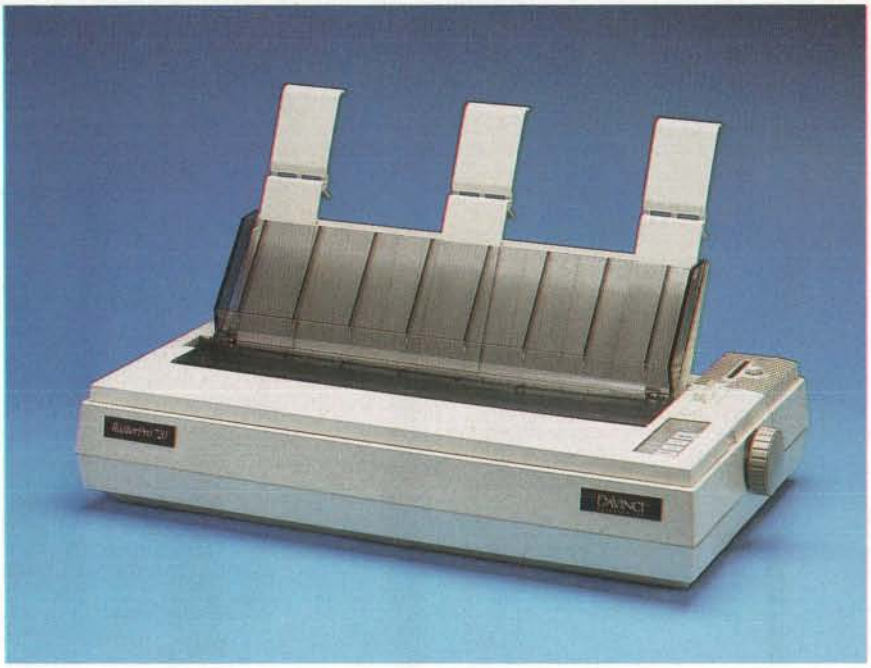
Stanford Diehl

REVIEW

Da Vinci Does It Penlessly



Just as I received Da Vinci Graphics' RasterPro 720, a color dot-matrix printer with Hewlett-Packard Graphics Language plotter emulation, laser printers started rolling in for an upcoming BYTE Product Focus. The timing could not have been better. These new laser printers either pack HPGL as a standard feature or offer it as an option, so they could compete directly with the RasterPro for the draft plotter market.

Da Vinci, on the other hand, doesn't see it that way. It markets this customized Fujitsu 24-pin printer as a final-quality A-/B-size color plotter to augment or even supplant the HP 7475A and other pen plotters. A busy workgroup would appreciate the RasterPro's speed, while its output quality should satisfy a discriminating design shop. Da Vinci calls it the Penless Plotter, and the product certainly boasts some notable advantages over the traditional pen plotter, and even over laser printers with plotter emulation. However, you've got to wonder whether the RasterPro's advantages can justify its $3495 list price. By comparison, the HP 7475A lists for $1895, and Brother's HL-8e, our test laser printer, costs $2895.

Read the Small Print

Don't get me wrong. This is a sturdy, reliable, and thoroughly impressive dot-matrix printer. When I passed around a pair of CAD drawings, one from the RasterPro and one from the venerable HP 7475A pen plotter, BYTE editors often needed a second look to tell the difference between the two. While the RasterPro could not match the vibrancy of the HP's pen colors, it did match the plotter's output in almost every other respect (see the photos on page 180). It even surpassed the HP plotter in such critical considerations as small-print clarity.

After your CAD work is done, RasterPro gives you a color printer to play with. Da Vinci does not recommend the RasterPro for business presentations and other applications that require a lot of solid fills. But when I pumped out some Quattro Pro graphs with the RasterPro emulating a color Fujitsu printer, I was pleasantly surprised. I even printed some color graphics from PC Paintbrush and appreciated the results.

Solid fills on the RasterPro do suffer from "banding" (noticeable lines that stripe the filled areas), and the RasterPro did not produce final-quality graphs using its plotter emulation. In Fujitsu mode, however, it held its own against the 7475A. The figure compares the two, along with the Brother HL-8e running HPGL. Each set of bars was produced by the device depicted: HP's pen plotter drew the first set of color bars, the HL-8e laser printer produced the next set, and the RasterPro drew the draft and final-quality bars in the last set. As you can see, the RasterPro generates credible color.

The Color Crisis

Printing in color did expose some serious problems with the RasterPro 720. The printer uses a four-band ribbon (with red, yellow, blue, and black) to deliver the color. It creates secondary colors by laying down first a track of one color and then a track of a second color—for example, to create green, it lays down a blue track and then a yellow one. I found that during the yellow pass, the yellow portion of the ribbon picked up blue ink from the paper. In a short while, yellows were tinged with green, and reds cast a shadow of purple. I went through three ribbons in short order. However, if you stick to the basic colors and avoid mixes, your ribbons should hold up. In any case, the RasterPro should still command less money for consumables over the long haul than either the laser printer or the pen plotter.

The RasterPro's brightest quality is its speed. The benchmark results in the figure don't take into account the RasterPro's 512K-byte print buffer. Although the RasterPro took more than 10 minutes, 2 seconds to pump out a Vellum CAD drawing, the keyboard became free after only 31 seconds. With the replot feature, you can generate as many copies as you like without bogging down your computer one iota. The 7475A, on the other hand, plodded through the Vellum drawing in 13 minutes, 52 seconds and tied up the keyboard for the lion's share of that time. Clearly, the RasterPro requires less babysitting than a pen plotter. In fact, if you have a lot of copies to generate, you can simply press the replot button as many times as needed and go home.

For our benchmark tests, I plugged the HP 7475A plotter into my serial port, and I cabled the RasterPro to my parallel port. At first this setup reeked of incompatibility. The RasterPro employs HP 7475A drivers, but AutoCAD would not allow me to talk to a plotter through my parallel port. The good news, of course, is that you can send the AutoCAD plot to a file on your hard disk and then whisk it out via the parallel port with the simplest of DOS commands: `Copy sample.plt LPT1`. For that matter, you could also print to a file from AutoCAD, designate LPT1 as the file, and still print directly from the AutoCAD interface. If you

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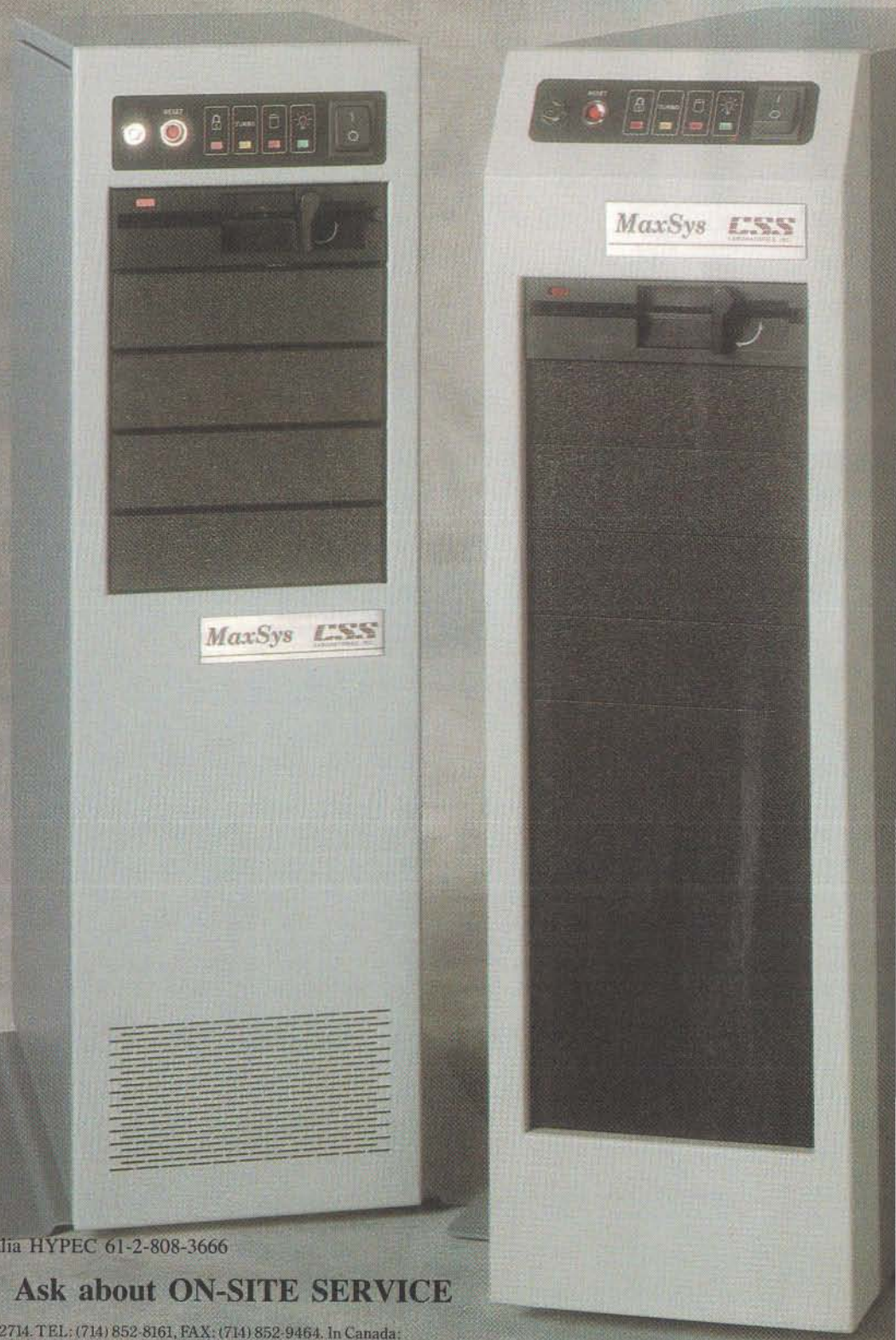

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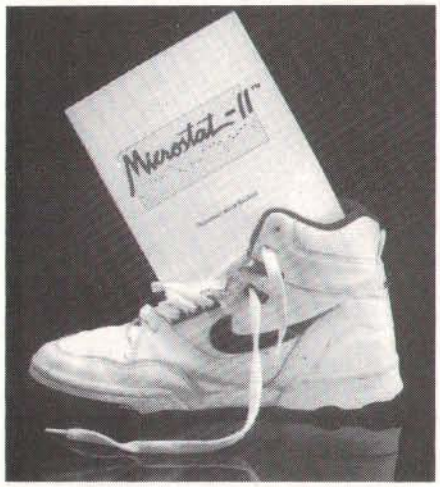

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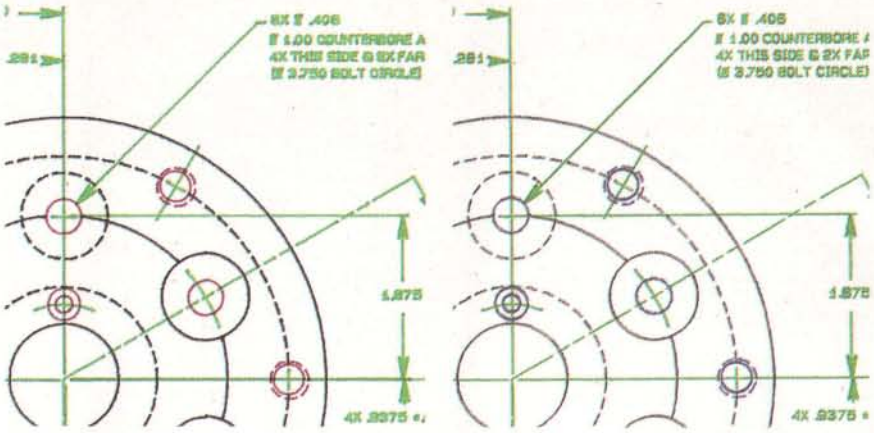
sist on using the slower port, Da Vinci offers the plotter with a serial interface for the same price as the standard parallel model.

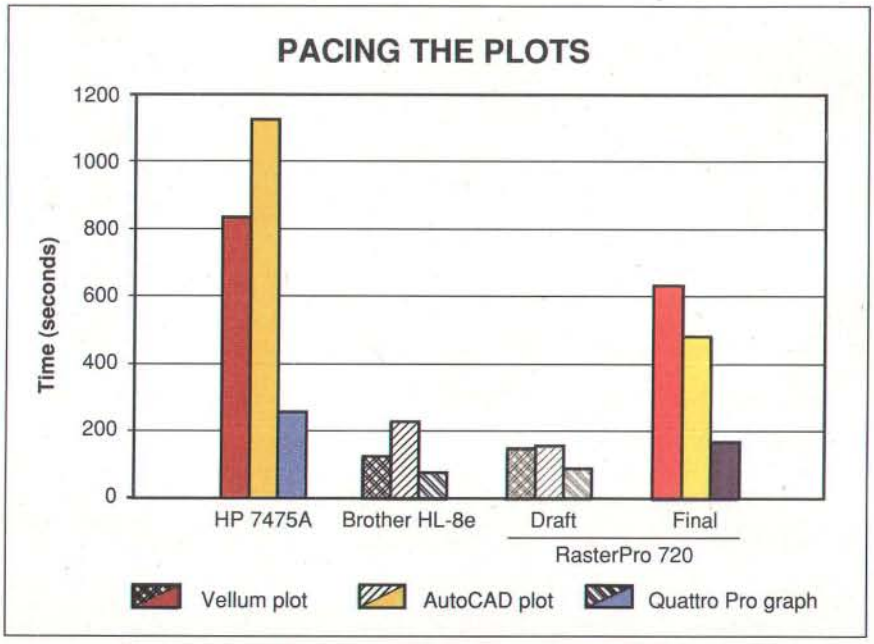
Penless Possibilities

While the Brother HL-8e laser printer beat out the draft-mode RasterPro in two of the three speed tests, Da Vinci's offering still freed the keyboard sooner. Both printers pack large buffers, but the RasterPro sucks the data out of your system faster. In the end, that's what really counts: how quickly you can get back to work. Still, if you're considering these two products purely for draft-quality purposes and you're not seduced by the lure of color and enhanced resolution, the less expensive laser printer would be the

continued



Two sample Vellum CAD drawings, one from the HP 7475A pen plotter (left) and one from the Da Vinci RasterPro 720 using 7475A emulation. While the HP pen plotter boasts more vibrant colors, the RasterPro comes very close to matching its output. It even drew smaller figures with greater clarity than the HP plotter.



Speed tests pit the HP 7475A pen plotter, the Brother HL-8e laser printer, and the RasterPro 720 against each other in both draft and final-quality modes. The final-quality RasterPro handily beat the HP plotter, while the draft-quality RasterPro and the laser printer ran a dead heat. In all cases, though, the RasterPro, with its 512K-byte buffer, freed the keyboard sooner. Each set of bars was produced by the device depicted to compare presentation-quality output. Here, the RasterPro emulates a color Fujitsu printer.

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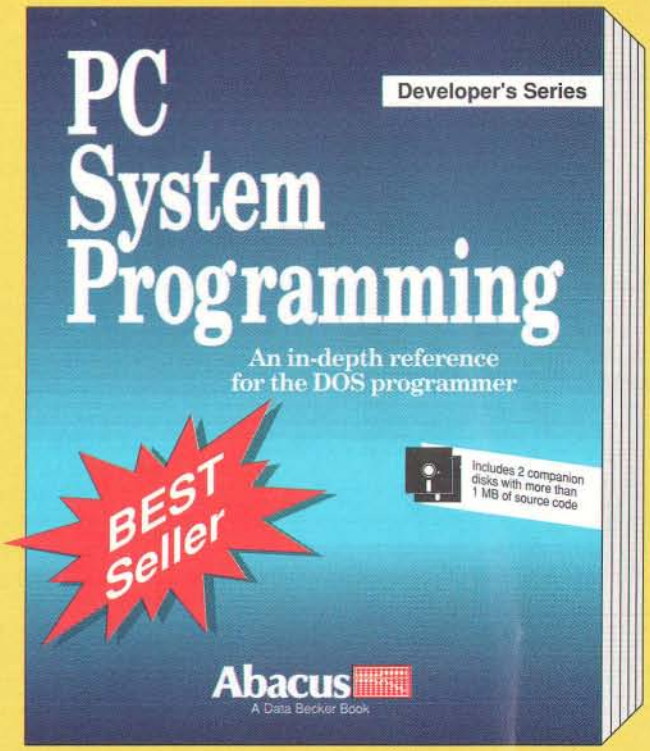

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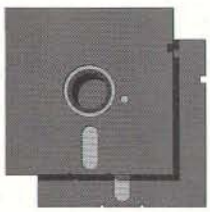

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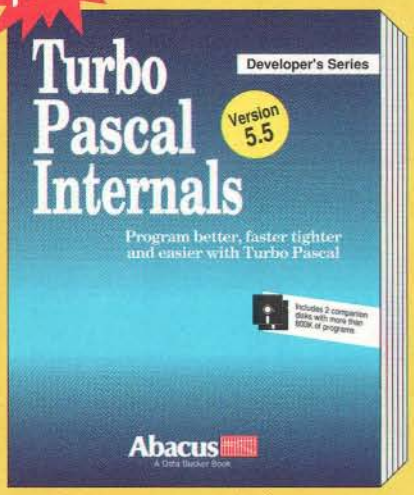

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RasterPro 720
Penless Plotter

Company
Da Vinci Graphics, Inc.
870 Hermosa Dr.
Sunnyvale, CA 94086
(408) 737-8800

Hardware Needed
Any PC with a serial or parallel port

Software Needed
Printer drivers for selected emulations

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sensible way to go.

Most laser printers use a more elegant LCD interface than the RasterPro, which prints menu choices on paper, as high-end 24-pin printers and many pen plotters typically do. Using buttons on the control panel, you move the print head over a desired option to select it. This seems awkward and wastes paper, but it does provide you with a hard-copy record of your selections. You can also store four different configurations (two in plotter mode and two in printer mode) and enable the active configuration directly from the control panel, so you shouldn't have to cycle through all the menus very often. The printer emulations worked flawlessly with a wide range of software.

The Penless Plotter has a lot going for it: sturdy construction, impeccable HP 7475A emulation, 720-dot-per-inch resolution, and surprising color for dot matrix. That's a strong combination for design shops that need a reliable draft plotter. For larger plots (D and E size), you can pump out drafts quickly, and when it comes time for some in-house higher-ups to see your work, you can add a splash of color. For your customer's copies, you have the E-size pen plotter waiting in the wings. An A-/B-size pen plotter would offer better color, but it demands more upkeep, more money for supplies, and constant attention. And a 300-dpi laser printer cannot produce comparable resolution, color, or B-size plots.

If your design shop generates a lot of A- or B-size technical drawings, take a look at the RasterPro. You'll have a viable substitute for an A-/B-size pen plotter, plus you'll have a fast draft plotter for your larger drawings and a 24-pin color printer to boot.

Da Vinci might have hit it big with this product, back when color dot matrix was a hot item. But now laser printers are all the news, and with the new breed delivering full plotter emulation, the RasterPro will face some brutal competition. Still, if the price drops some, you might choose the RasterPro just to put a little color in your CAD. ■

Stanford Diehl is a testing editor for the BYTE Lab. He can be reached on BIX as "sdiehl."

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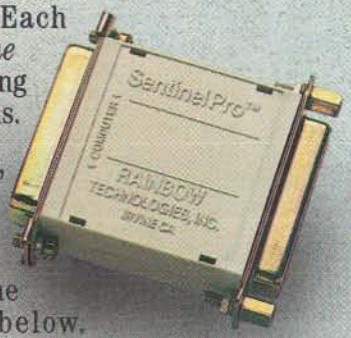

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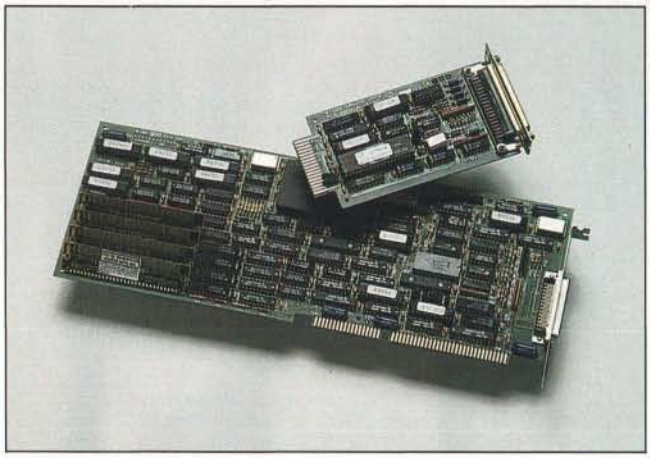
Don Crabb

REVIEW

Fast Fonts: PostScript Gets Turbocharged



The StellarPS full-size controller board holds Intel's new i960 RISC chip. The smaller video adapter board plugs into a LaserJet Series II printer.

PostScript aficionados know how necessary that page description language is for printing numerous fonts, adding special effects, and incorporating artwork and other nontext components into documents. But the trouble with PostScript is its turtle-like speed. Because it relies on many complex data structures and numerically intensive transformation operations, it tends to eat up a printer's processor power.

Enter HanZon Data's StellarPS controller. Install it in your PC and Hewlett-Packard LaserJet Series II printer, and be prepared to watch PostScript files fly.

StellarPS

Company
HanZon Data, Inc.
22032 23rd Dr. SE
Bothell, WA 98021
(800) 842-8540
(206) 487-1717

Hardware Needed
HP LaserJet Series II printer (Series III support announced); IBM PC, XT, AT, or compatible with a hard disk drive with 1.8 MB of free space

Software Needed
MS-DOS 2.0 or higher

Price
$2595

Inquiry 852.

The StellarPS uses Intel's i960KB RISC chip, an embedded microprocessor that eats PostScript commands for breakfast.

RISC Rewards

At press time, the $2595 StellarPS worked only on the Series II and PCs (HanZon has announced software and hardware upgrades to support the LaserJet Series III printer, which should be shipping by the time you read this). If you are looking to accelerate PostScript from an Apple LaserWriter, StellarPS can't help you. Likewise, the controller fits only into a full-size PC slot; NuBus versions aren't available for the Mac.

The idea behind the StellarPS is amazingly simple, yet its execution is fairly complex. The brains of the StellarPS is the Intel 32-bit RISC microprocessor. It boasts a 20-million-instruction-per-second burst execution rate, with a 7.5-MIPS sustained rate at 20 MHz. In the StellarPS, the i960 is clocked at 16 MHz, which cuts performance a bit. The i960 includes an on-chip FPU, has four 80-bit registers, and has been certified by Intel to pump out 4 million Whetstones per second (when clocked at 20 MHz). That is serious floating-point performance. The i960 is the first of Intel's new 32-bit microprocessors to be specially designed for embedded applications, such as accelerated PostScript processing, 32-bit video, image processing, and other high-speed, high-bandwidth applications.

The StellarPS is a two-part controller system. Its full-size controller board, with the microprocessor and 4 megabytes of RAM, plugs into your PC. You load 1.8 MB of controller software onto your hard disk. Then you install another, much smaller video adapter board (yes, I said video) into the I/O slot of your HP LaserJet Series II printer. Finally, you hook the StellarPS controller to the newly installed video adapter on the LaserJet with the supplied parallel cable. That's it, except for running the installation program that optimizes the StellarPS for your particular environment and makes sure that you don't have any RAM conflicts. The StellarPS requires a 16K-byte memory window (e.g., D000-D3FF).

Now you're ready to roll—and this baby definitely does. Expect PostScript performance three to 10 times faster than an Apple LaserWriter IINTX, which is no performance slouch itself. For example, I printed a one-page Microsoft Word 5.0 letter consisting entirely of PostScript text in just 4 seconds with a StellarPS-powered Series II. The same document took 27 seconds on the LaserWriter IINTX. The figure shows equally impressive results with larger text files and mixed text and graphics files.

Blasting Rasters

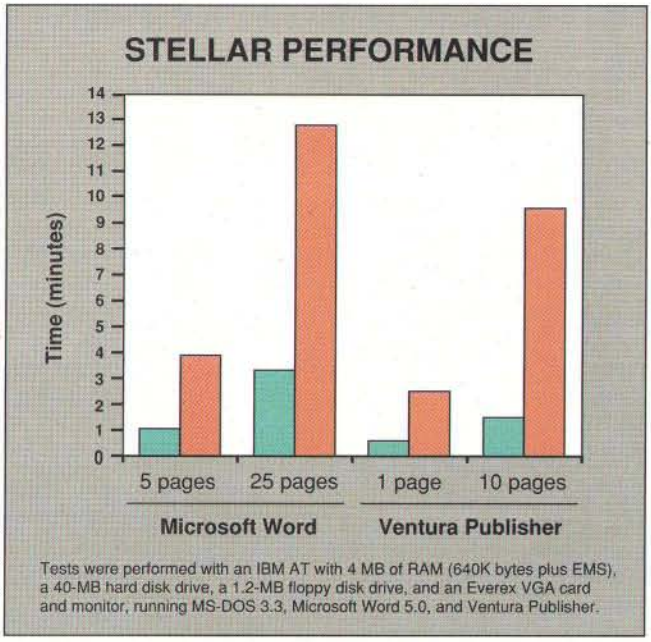
The StellarPS is a full-blown printer controller with its own CPU, RAM, and control logic. It's not a cartridge-style PostScript add-on that downloads to the LaserJet at print time. The StellarPS composes the PostScript pages on-board and blasts them as a series of video rasters (see where the video adapter comes in?) across the parallel cable to the video adapter on the printer. There the Canon LBP-SX printer engine renders the rasters and fuses them to the page.

The controller bypasses the LaserJet II's Motorola 68000-based controller (which uses HP's Printer Control Language IV). You can still print non-PostScript jobs if you leave the original PC-to-LaserJet cable connected when you install the new controller. By separating the LaserJet's print engine from its built-in controller, the StellarPS gains part of its dramatic performance improvement.

Unlike competing controllers that do not include their own microprocessors (they are essentially PostScript-download reservoirs), the open architecture of the StellarPS/LaserJet II combo is optimized for maximum page throughput. The StellarPS talks to your PC at its bus speed, which is much faster than the standard serial or parallel interface that the LaserJet II supports. This also helps to account for the added speed.

Overall, the printing architecture defined by the StellarPS/LaserJet II system

As the test results show, the StellarPS/LaserJet Series II combination printed text-only (Microsoft Word) and mixed-text-and-graphics (Ventura Publisher) PostScript files three to five times faster than an Apple LaserWriter IINTX PostScript printer.



is reminiscent of that used by video controllers (indeed, the i960 microprocessor has video application potential for other embedded environments). All the setup, printer control, status checking, and data transfer occur within the PC and the StellarPS, while the mechanical printing processes are shared between the StellarPS and the LaserJet II.

Real PostScript or Brand X?

An on-board Adobe-licensed PostScript interpreter used to be the definition of 100 percent PostScript compatibility. That has changed. Microsoft has acquired a PostScript-compatible interpreter from Bauer that processes all Adobe-standard PostScript commands and works with any Adobe PostScript font (as long as it's not encrypted); it also adds some commands that make text positioning easier in desktop publishing applications. The StellarPS uses this Microsoft/Bauer PostScript-compatible superset.

I performed "is this thing really PostScript" print tests from Microsoft Word, Aldus PageMaker, Microsoft Windows, and Ventura Publisher. It's really PostScript. Text rotated as expected. Art rendered as expected. It's so close to the real McCoy that compatibility won't be an issue for many applications. There were differences between the StellarPS/LaserJet II's output and output from my baseline PostScript system (an Apple LaserWriter IINTX), but they were minor and mostly attributable to the fonts involved.

Just as with its "PostScript" language, HanZon did not license its "PostScript fonts" from Adobe (which probably saved it a bundle). Rather than including the exact 35-font set provided by Apple (11 font families) with the LaserWriter IINTX, HanZon licensed Bitstream's versions of those same fonts. Although graphic designers, keyliners, and editors can tell the difference between an Adobe Helvetica Narrow Oblique font at 15.5 points and the same font Bitstream-style, many nondesign professionals cannot. I could see the differences, but I was looking for them. In no case did I think the Bitstream fonts were uglier or less complete. They were just different from Adobe's, mostly in subtle ways. The design differences between these two font suppliers are dictated by copyright restrictions, not by font design considerations.

If you absolutely must have Adobe PostScript fonts, then you probably can't make do with the Bitstream equivalents in the StellarPS, but most users won't notice the difference. In any case, all 35 fonts are built into the StellarPS; you don't have to download them to the LaserJet. However, if you need to use soft fonts, the StellarPS will accommodate you. StellarPS fonts load into the LaserJet's memory as outline fonts when you fire up the printer and PC.

According to HanZon, the controller can work on a nondedicated Novell network server without any modification or special instructions, other than those needed to start the server and the printer and make sure that the StellarPS/LaserJet is the default network printer. I did not test the StellarPS on a Novell network, but given the way that the Novell

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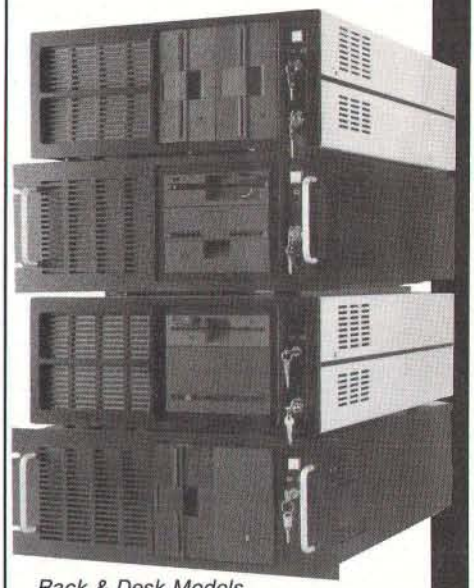

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CAPTURE command works, I don't see any potential problems in using it on a nondedicated Novell server. HanZon also promises to provide the necessary information for using the StellarPS on a dedicated Novell server, as well as within other networking environments.

The Bottom Line

Obviously, there's more than one way to add PostScript to your LaserJet II. In performance, the StellarPS goes the high-end route all the way; at $2595, it also costs a significant chunk of cash. If you don't need to produce your pages as quickly as the StellarPS can pump them out, then you might be satisfied with less expensive alternatives, like Pacific Data's PacificPage cartridge (see "PostScript in the Palm of Your Hand," January BYTE). It's much cheaper, it offers PostScript compatibility, and it's as slow as molasses compared to the StellarPS.

The real question is, do you need the speed? Most LaserJet II users are likely to be from the business ranks and may only print text and line drawings. These users probably don't need PostScript at all, let alone from a 7.5-MIPS controller. But if you're in a desktop publishing or high-volume networked environment, a $2595 controller and a LaserJet II (or III) can be a wise choice, especially since the combo will substantially outperform a $6000 LaserWriter IINTX. ■

Don Crabb is the director of laboratories and a senior lecturer for the University of Chicago computer science department. He is also a contributing editor for BYTE. He can be reached on BIX as "decrabb."

SYSTEM

Rob Mitchell

REVIEW

Small Footprint, Big Impression

In today's office, the PC is an indispensable tool—and the single biggest piece of clutter on the desktop. If you're on a LAN, Emerald Computers' 286-based LANstation I may be the perfect alternative. At just 14½ by 5¾ by 10¼ inches, it's the smallest diskless PC I've seen. It's also one of the most expensive.

The LANstation's display and 85-key AT-style keyboard make it close in design to a laptop. An electroluminescent flat-screen monochrome EGA display and the system logic reside in a molded housing that's sleek and attractive. The machine has one parallel and two serial ports, plus a slot for Epson 256K-byte and 512K-byte ROM cards (Emerald will sell you a ROM burner for $250 or will burn applications into ROM for a fee). Its two AT slots accept the motherboard circuitry and a network interface card.

The standard LANstation comes with a 12-MHz Harris 80C286 CPU and 1 megabyte of memory for $1895. My $2095 test machine included a 16-MHz CPU, an 80C287 FPU ($395), 1 MB of 80-nanosecond DRAM in single in-line packages, and a Tiara 16-bit Ethernet card ($349) with a NetWare boot PROM ($40). The total price is $2879. A 2½-inch 20-MB hard disk drive with a 27-millisecond average seek time is $500.

Construction quality was good overall, but my machine had two annoying problems. The power switch tended to stick when pressed, and the single peg leg supporting the left side of the case made the system unstable. Emerald said it was working to correct both problems.

The machine's display was clear and easy to read, which is important, since it doesn't have brightness and contrast controls. The display's aspect ratio, like that of most laptop screens, appears slightly squashed vertically. A jack for an external CRT would help for graphics applications. I also liked the keyboard; it doesn't feel cramped, and it has a good response.

The LANstation that I tested was a fast 286 machine. According to Emerald, the 16-MHz CPU runs at zero wait states, which places it ahead of the 12.5-MHz Wyse WY-212 and 10-MHz TeleVideo TS2 TeleStation, two 286-based diskless PCs that we tested last year (see "The LAN Terminal Alternative," November 1989 BYTE). On the BYTE benchmarks (which rate an 8-MHz IBM AT at 1 for each test), the LANstation posted a CPU index of 2.66 and a floating-point index of 1.57. The Wyse WY-212 logged 1.68 and 1.40, respectively, in these tests.

But the LANstation costs hundreds of dollars more than a similarly configured desktop machine *with* hard and floppy disk drives. Also, security is an issue, because anyone with a LapLink package can access network server data via the LANstation's serial and parallel ports.

Like other diskless PCs, the LANstation makes network administration easier by centralizing data storage at the server. But its main appeal is its small size and its styling. It's amazing how much space you gain when you pull an AT-size box off the desktop. You just have to decide how much that extra space is worth. ■

Rob Mitchell is a BYTE technical editor. You can contact him on BIX as "rob_mitchell."

LANstation I

Company
Emerald Computers, Inc.
7324 Southwest Durham Rd.
Portland, OR 97224
(800) 321-5711

Components
Processor: 12- or 16-MHz Harris 80C286; socket for 80C287
Memory: 1 MB of 16-bit 80-ns DRAM chips in 256K-byte SIPs, expandable to 4 MB; slot for ROM disk cartridge
Mass storage: None
Display: Built-in monochrome, 8½-inch electroluminescent monitor; 640- by 350-pixel EGA graphics; circuitry built into motherboard
Keyboard: 85-key modified AT with RJ-11 interface
I/O interfaces: Two 9-pin serial ports; one 25-pin parallel port; 16-bit AT-bus expansion slot for LAN adapter card

Size
14½ × 5¾ × 10¼ inches

Price
Base system: $1895
As reviewed: $2879

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Martin Heller

REVIEW

Just Add Water

Instant-C 4.0's windowed debugging environment.

Most C programmers don't spend much time thinking about Lisp, but the technical staff at Rational Systems did. They looked at the productivity of Lisp programmers and concluded that C was a clod by comparison. Rational set out to create an environment that would give C programmers all the conveniences available at a Lisp workstation, including immediate execution, incremental compilation, automatic formatting, easy browsing, and built-in source-level debugging. When the wraps came off, Instant-C was born.

Rational Systems' first attempt to boost C programmers' productivity was stymied a bit by a popular misconception: Too many potential users thought Instant-C was a C interpreter. So, instead of touting its unique abilities, Rational found itself in unwilling competition with other interpretive versions of C.

Instant-C 4.0 has come a long way from that first "C interpreter." It's not built on an interpreter (and never was) but rather on an incremental compiler. The difference is speed: Instant-C runs your code a good 10 times faster than C interpreters but a factor of two or three times slower than most optimizing compilers.

Rising Above Adversity

Given that the incremental compiler, the monitor, the debugger, your compiled program, and your source code all have share memory, the 640K bytes available under DOS was a crippling limitation for earlier versions of Instant-C. Instant-C 4.0 surmounts the DOS memory limit using Rational's DOS/16M DOS extender to run in protected mode. For programs that break the rules of protected mode, Instant-C 4.0 offers, in addition to pure protected mode, a mixed mode of operation where Instant-C itself runs in protected mode, and your compiled program runs in real mode.

Instant-C (and DOS/16M) honors the Virtual Control Program Interface convention for managing protected mode. I ran Instant-C from my normal DOS environment, which includes DOS 3.3, 386Max, Super PC-Kwik Power Pak, the Hitachi CD-ROM driver, Microsoft's CD-ROM extensions, and the Logitech mouse driver. Getting all this stuff to work at once is something of a juggling act. Some other protected-mode programs, which do not honor VCPI, forced me to reboot my computer with a simpler configuration before I could use them.

How good is Instant-C's protected mode? I had Instant-C and all of the image-display program (IMDISP), which I will discuss later in this article, loaded in high memory in protected mode. I wrote this article in Sprint running in a real-mode DOS session shelled out from Instant-C. I could even shell out again from Sprint to execute DOS functions; when I finally closed Sprint, I could still go back immediately to Instant-C. That's productivity.

Cycling Around the Learning Curve

At one time, the standard picture of how software is developed was the "waterfall model." In it, software is first specified, then designed, then implemented, and finally tested.

My own development style involves many iterations in the development process. When I write code, I quickly build up a user interface—sort of an armature—that reflects the design of the program as a whole but doesn't implement too much code that actually does anything. The users get to see the shell and comment while I start to code the most important innards. At weekly intervals, stable versions with additional features go out for testing and comment; I then fold the test results into the next week's development.

Working in this way lets me break the development process into tasks lasting one to five days each. While I work on each task, the task's module is fluid while most of the rest of the program is frozen. I spend a lot of time editing, compiling, linking, and testing. Running the code teaches me things I didn't know when I was designing, so I modify the design as I go.

Instant-C shortens the cycle time once I'm into a project, but it has its own start-up costs. With the program, I can make a change in a function and be ready to start testing (with full source-level debugging) in 10 seconds. That's an enormous improvement in cycle time, and I can get much more accomplished. By issuing calls to a new function from the Instant-C command line, I can even test out of context.

However, the learning curve for Instant-C is steep. To begin with, I had to build a version of Instant-C with the Microsoft libraries I normally use. The standard version of Instant-C uses Rational's own libraries, but tools are supplied that build versions compatible with the large- and medium-model libraries supplied with Microsoft and Lattice C compilers. The rebuild went smoothly.

Then I had to load my code into Instant-C. Understand that this is code that compiles without error in Microsoft C. Instant-C is a little fussier, however. Since it knows about all the modules of a project, it can combine the checking of a compiler, a linker, a debugger, and `lint`.

I originally tried to load a project that embodies over 20,000 lines of C code and uses several third-party libraries: Vermont Views, MDBS IV, Essential Graphics, The Heap Expander, and TurboGeometry. I have source code for all but MDBS IV. As shipped, the program and its overlays take 600K bytes of disk space but run in a little over 300K bytes of code space.

Rational was able to supply me with support files for Vermont Views, Essential Graphics, and some other libraries that I use in other programs. I could easily have disabled my Heap Expander

continued

Instant-C 4.0

Company
Rational Systems, Inc.
220 North Main St.
Natick, MA 01760
(508) 653-6006

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A 286- or 386-based PC with at least 1 MB of RAM

Price
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Inquiry 881.

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Bill Machrone
PC Magazine, January 17, 1989

Good things do get better."
John Dlugosz
Dr. Dobbs Journal, September 1989

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code, but I was stuck on the problem of supporting MDBS IV.

Instant-C can load object code and object libraries, but you have to tell it what the object code is doing. To do this, you write an .IC file that looks a lot like C prototypes. I wouldn't have too much trouble converting my MDBS IV function prototypes into an Instant-C file, but I already knew that some of the MDBS IV code registers arithmetic, which is forbidden in protected mode. As I didn't have source code and the project was too large for Instant-C's mixed mode, I was forced to choose another project.

The IMDISP Project

IMDISP, written at the Jet Propulsion Laboratory under a NASA contract, is used to display planetary and satellite data. As supplied, IMDISP knows about standard VGA modes, but not about the Super VGA modes of my Video Seven video RAM card. Adding support for my VGA card seemed like a good test for Instant-C, for several reasons: IMDISP includes one assembly module and a lot of DOS- and hardware-dependent code, it's reasonably sized (some 8000 lines of C and 500 lines of assembly), and I wasn't familiar with its code.

When I tried to load IMDISP into Instant-C, I discovered bugs in both. Instant-C helped me find and fix several relatively benign errors in IMDISP, and IMDISP revealed a couple of nasty errors in Instant-C. Rational quickly supplied me with a later version of Instant-C (4.02) in which all the bugs I discovered were fixed. Unfortunately, in the course of working through IMDISP, I discovered a few more problems with Instant-C. As of this writing, the folks at Rational were able to duplicate and isolate all the errors that I found; they told me that these errors would be fixed in the next version of Instant-C. By the time you read this, even that version will be history. With any luck, Instant-C 4.1 will be stable and shipping.

Once I got IMDISP loaded into Instant-C and running, my job was quite easy: Instant-C's browsing and cross-referencing features made finding the code that I needed to modify almost trivial. I could have done the same thing using my standard tools and `grep`, but I would have spent more time doing the edit/compile/link/test cycles. Instant-C's debugger seemed to give me more control and better diagnostics than CodeView—protected mode isn't perfect, but it sure helps in finding uninitialized pointers and other common problems that can be totally baffling under DOS.

The Instant Conclusion

Was all the pain I went through bringing my code into Instant-C worthwhile? Probably. I'd be more likely to start my next project in Instant-C than to start it with my usual tools. I have learned that moving code from Instant-C to a compiler is as painless as the reverse is painful.

On the other hand, Instant-C can't handle Windows code, which sends me back to my usual tools for Windows programs. Nor does Instant-C help much for programs targeted for OS/2. But Instant-C sure helps in developing large (and small) C programs for DOS: It finds errors that seem to elude even hardware-assisted debuggers.

I can wish for more, of course. Currently, Instant-C's editor only handles one object at a time; I would like to have many different functions open at a time, as I can in other DOS programmer's editors. I would also like to see the Instant-C editor integrated with the program's symbol table and its knowledge of C syntax: There is no reason, in principle, that Instant-C could not do truly intelligent template editing and name completion.

At $795, Instant-C isn't cheap. It also won't finish a project for you satisfactorily; you still need an optimizing compiler to generate production-quality code. But as a productivity enhancement tool, even counting an initial week lost to learning time, Instant-C is likely to cover its costs in a couple of months. By my standards, Instant-C is something any full-time, professional C programmer working in DOS will want to have in his or her toolbox. ■

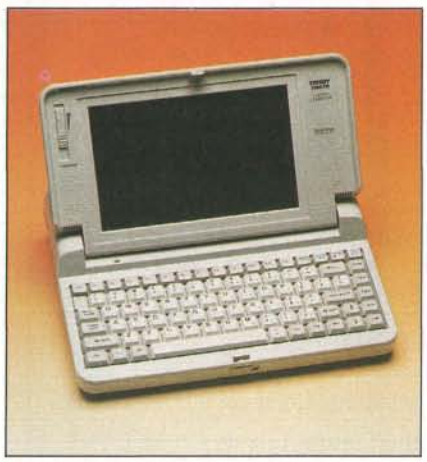
Martin Heller develops software and writes about technical computer applications. He lives in Andover, Massachusetts. He can be contacted on BIX as "mheller."

SYSTEM

Stan Miastkowski

REVIEW

Thoroughly Totable Tandy



In the battle for the hearts, minds, and dollars of portable computer users, two product camps exist: the high-end, feature-packed, and budget-beating portables like Compaq's LTE/286, and the low-end systems with minimal features and a more affordable price.

Tandy has opted for the low end. Its new 1100 FD features a price tag of $999 and a list of features that are less than technologically earth-shattering.

At the heart of the 1100 FD is an 8-MHz NEC V20 (8088-compatible) CPU. There are also 640K bytes of RAM, a single 3½-inch 720K-byte floppy disk drive, and serial and parallel ports. The 9-inch-diagonal screen offers a resolution of 640 by 200 pixels.

Weighing just under 6½ pounds, the 1100 FD is well within the comfort range for all-day toting. However, I was miffed to find that the outside dimensions (12⅛ by 2½ by 9¾ inches) make the 1100 FD about ¼ inch too long to fit sideways in a standard briefcase.

Although Tandy missed the boat on "fitability," it did an excellent job in usability. The screen isn't backlit, but the system's supertwist neumatic green display is surprisingly easy to see, even in a dimly lit hotel room.

Another surprise is the keyboard. Like every other laptop maker, Tandy has its own peculiar layout. But the 1100 FD's 84-key configuration isn't bad, and the arrow keys are easy to use. I also liked the feel of the short-stroke keys.

Of course, the single floppy disk drive and the lack of a hard disk drive limit you—a lot. But like others, Tandy put the

continued

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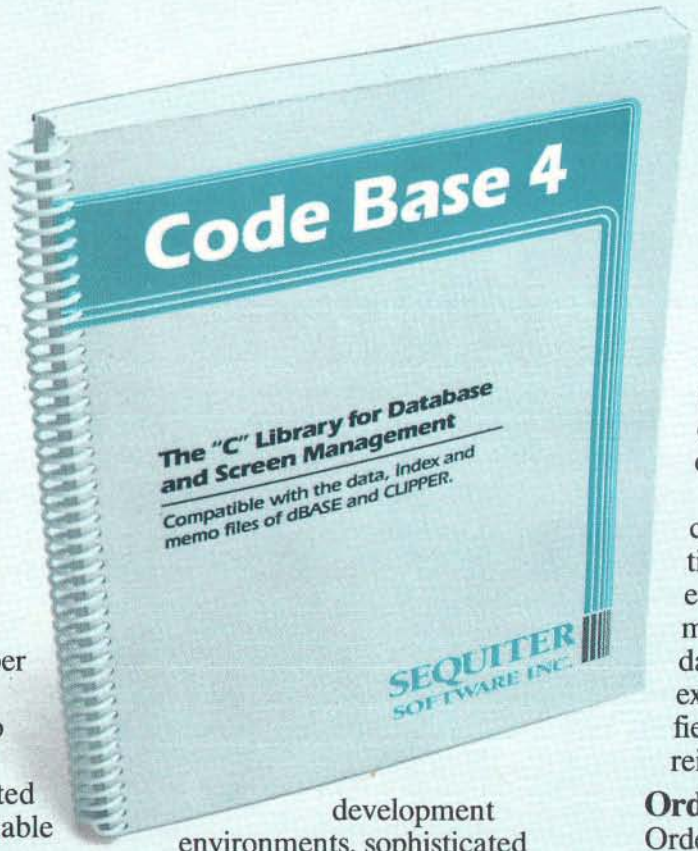

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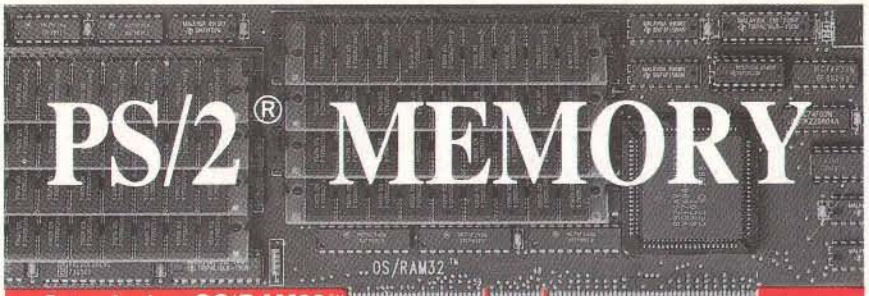

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REVIEW

1100 FD

Company
Tandy Corp.
1800 One Tandy Center
Fort Worth, TX 76102
(817) 390-3011

Components
Processor: 8-MHz NEC V20
Memory: 640K bytes
Mass storage: Internal 3½-inch 720K-byte floppy disk drive
Display: 9-inch, 640- by 200-pixel, supertwist neumatic LCD
Keyboard: 84-key
I/O interfaces: One 9-pin serial port; one 25-pin parallel port; internal modem slot

Size
12⅛ × 2½ × 9¾ inches; 6½ pounds

Price
$999

operating system (DOS 3.3) in ROM. Also in ROM is the basic shell of Tandy's DeskMate, a character-based graphical user interface. I find DeskMate a taste that I haven't been able to acquire. Because the 1100 FD version kept asking me to swap among three floppy disks, I decided to return to plain-vanilla DOS within minutes.

Although small in size, the system's built-in rechargeable battery lasts for about 4½ hours—even longer if you don't use the floppy disk drive. For those increasingly common flight delays, this is an important feature indeed.

The 1100 FD certainly isn't the laptop for power users, but it is light. In addition, it works on battery power long enough to make it useful for on-the-road basics, like memo writing and record keeping. While $999 isn't cheap, it is well within the range of comparable systems, especially since Tandy put all the basic necessities (and then some) into the standard package. The only options available are extra battery packs ($30) and a $200 internal 2400-bps modem. With the modem, the 1100 FD is an almost perfect companion for a travel-weary journalist.

Now, if I can just figure out how to saw half an inch off the case. ■

Stan Miastkowski is a consulting editor for BYTE. He can be reached on BIX as "stanm."

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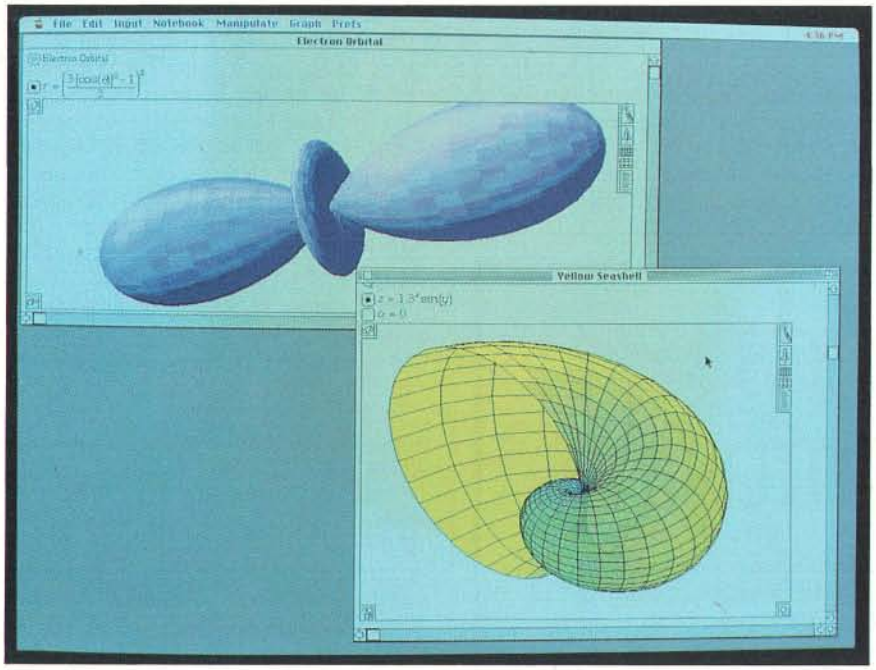
REVIEW

The Zen of Symbolic Math



Like Mathematica, Theorist plots complex functions like the ones shown here. It can also animate a function based on a range of variables.

Sometimes late at night when I'm solving equations, the paper seems to come alive, and the variables move left and right beneath my pen as a solution evolves. An x^2 may jump across the equal sign to cancel out an identical term, or the product of two exponents may combine to make integration easy. Come morning, though, the paper always seems to lose its magic.

But Theorist captures a great deal of this logical animism in the point-and-click world of the Macintosh. The software is written by Prescience, which also created the highly regarded equation typesetter Expressionist.

The most revolutionary part of Theorist is its user interface. With Theorist, the mouse is an important tool; you use it not just to cut and paste but to *visually* manipulate the equations. You can drag variables and forms left and right, and the program will keep the equation balanced and consistent on the screen.

The user interface's flexibility is Theorist's strongest point. The guts of the product, the symbolic mathematical engine, is not as strong as that of Mathematica, Maple, or Macsyma. Theorist relies more on the user for direction, making it a lot more like a fancy sheet of paper than a mathematical oracle. That's not necessarily bad, because automatic symbolic manipulation can be tricky to correct when the mathematics get complicated. In these cases, clever algorithms can generate wrong answers when bugs get in the way. Theorist avoids this problem, for better or worse, by leaving most of the intelligence up to the user.

Theorist 1.01

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Mathematical User Interface

Once you've typed the equations to a particular problem, you use the mouse almost exclusively. You isolate a variable by selecting it with the mouse, and then you can drag it to the opposite side of the equation. Theorist balances the equations and does the simple work of calculations.

You don't have to enter equations exclusively by the keyboard, either. A large palette contains all the different types of operands, such as multiplication and integration, as well as the currently defined variables. If you do use the keyboard, Theorist provides two different input modes. In the first mode, you indicate different relationships, such as subscripts and exponentiation, by using keystrokes to move the cursor. This is similar to the method used in Expressionist. Alternatively, you can use the "FORTRANish" mode in which Theorist accepts equations with all the parentheses—just like a FORTRAN compiler. The system is flexible, and anyone who favors the mouse or the keyboard will not be unduly forced to use the other.

You can manipulate the equations in a window called a *notebook*. Theorist's notebooks behave differently than the windowed notebooks Mathematica uses. Mathematica's are essentially fancy transcriptions of the commands that the user issues. Theorist's notebooks, on the other hand, are collections of assertions called *propositions*. Propositions can also be comments, transformational rules, or declarations about whether the e should be treated as a variable or the famous constant.

These collections of propositions hold the system's knowledge. If you enter the proposition $z=100$ on a line of the notebook, Theorist will use that value in any later calculations in the window. If you edit the proposition, changing the value of z, you also change the state of the system. The change, though, does not percolate throughout the equations on the page. You need to explicitly redrag the equations to recalculate the new values. This is because Theorist keeps all the old results on the screen and does not erase them.

Theorist's entire format has a feel that should be very pleasing to mathematicians, because it encourages the user to think of the equations as propositions. Mathematica and Macsyma, on the other hand, act much more like answer dispensers.

Manipulation vs. Automation

The questions that the user interface raises are not merely stylistic; they also

continued

concern functionality. Theorist can do plenty of the basics, but it cannot make many combinations of them. It can manipulate equations with any combination of real numbers, integers, complex variables, integration signs, derivative operators, matrices, vectors, cases, series summations, and products. The equations or any part of them you select with the mouse can be simplified, expanded, collected, isolated, or integrated by parts. Theorist can also substitute the equations into each other through combination.

Theorist can also apply rules that are either user-defined or from the selection of basic rules that are provided in extra notebooks. The program comes with an entire notebook filled with rules for integration, and they cover most of the standard tables. In addition, you can add your own rules to the simplifier and the expander routines to affect how these routines work. These rules are, however, the only method for extending Theorist.

There is not much more capability beyond these basic techniques. Theorist is not as powerful as other symbolic packages, and because of this, it will rarely string these basic manipulations together to find the answer for you. This doesn't mean you can't use the system to do more than $x+y$; it just means Theorist won't do all the work. For instance, you cannot type in a matrix and then get the eigenvalues—you must type in the matrix (m) and the equation for the eigenvalues ($\det|m-\lambda I|=0$) as propositions. Then after a minute or so of manipulating the propositions with the mouse and isolating the scalar λ, the answer appears on the screen. The bulk of the work that Theorist does is either arithmetic or tracking thousands of details—intelligence is not its forte.

The limitations are not necessarily bad. The manual prefaces one example of how to solve a difficult integral with the remark, "Rumor has it that even some of the high-end symbolic algebra packages have trouble with this one. Using high-level human intelligence and low-level computer algebra, we can solve it." This is not just a coy way of passing the buck, but an intelligent alternative. Symbolic algebra systems can be very dangerous if you don't know what the answers should look like. They can numb the mind and lead to mistakes when communication breaks down.

I made one mistake like this when I was using another symbolic package. I typed `Integral[Sin(x),x]` instead of `Integral[Sin[x],x]`. Using the parentheses around the x instead of the brackets changed `Sin` from the transcendental function to a constant, and the answer became $\mathtt{Sin}((x^2)/2)$. This is just a simple typographical example of how ambiguities and built-in intelligence can combine to cause errors. In the same way, a super eigenvalue-finding algorithm might be right in most cases, but it can also fail when the user's assumptions don't match the computer's.

Theorist takes the low road and prevents these mistakes by being dumb. It asks you to define everything. Each name must be formally defined as either a constant, variable, function, M-linear operator (an operator that follows associative and commutative rules, like those that govern matrices), or D-linear operator (an operator that is linear but is not M-linear). When you first use a name, Theorist asks you to choose one of these classes for it. It doesn't assume anything

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about names such as Sin, Cos, or *e*. This precision can get tiresome, but the notebook lets you set up a section of preferred definitions.

This lack of automation can help when rules are applied. If Theorist finds two different rules in its tables for transforming an equation, it prompts the user to choose the correct path. Other systems, break these ties by choosing the first rule it finds. This is fine if the first rule is the correct one.

Unfortunately, Theorist doesn't put all the power in the hands of the user. Even in the reference manual the company explicitly states, "Trust us that we used the 'correct' algorithm." If I'm doing numerical integration around a singularity, I want to know what the program is about to do so I'll know if a mistake is likely.

Of course, that only points to the basic problem in symbolic algebra software: Developers are hesitant to provide sufficient information about the algorithms because they consider the information to be proprietary. This is certainly understandable, but it is frustrating when errors arise.

Seeing Is Believing

Theorist can, however, make amazing graphs of the functions you define. The system can make full color graphs in two or three dimensions. These can be either simple graphs, parametric plots, or polar plots.

You can select color or black-and-white shading to add a fourth dimension to any three-dimensional equation, and you can easily define any range of relationships between the color and the function's value. By default, graphs can be either translucent, transparent, or opaque to represent complex values.

The graphing ability is well integrated with the problem-solving apparatus. The root-finding command is located on the Graph menu, and you can activate it only when a graph is on the screen. If you want to find out exactly where a function crosses the *x*-axis, you simply isolate this section of the graph and call up the root finder. You must make sure that you have zoomed in close enough that there is only one root on the screen, and Theorist takes it from there. This is a nice way to combine visual and symbolic representations of functions.

The program can also animate a function graph as one of its parameters ranges between two values. You can even save the animation in a PICS file so another program can use it. This is an easy way to get a visual sense of a graph.

Theorist has one of the most amazing math user interfaces. It actually lets you interact with the equations on the paper. The equations can come alive, but they need you to wield the mouse like a cattle prod and send them to the correct position.

Mathematicians will find Theorist especially comfortable to use, because it treats the entire problem session as successive derivations of propositions. This can be frustrating if you are looking for a quick solution, but it can actually save plenty of time when you need to know how the equations work. Like the oriental Zen masters who never gave the answers, Theorist will not show you the way—it will keep you on track. ■

Peter Wayner is working toward a Ph.D. in computer science at Cornell University. You can contact him on BIX as "pwayner."

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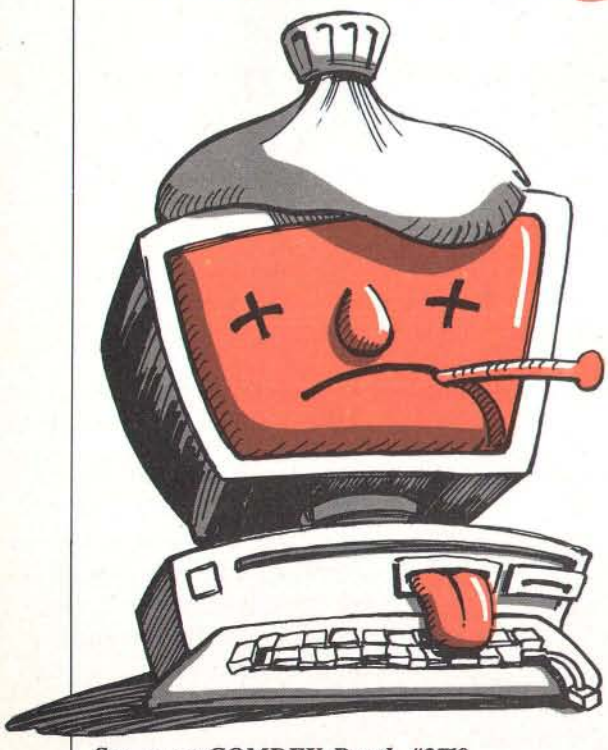

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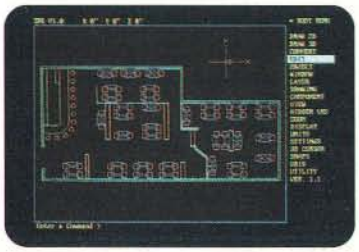

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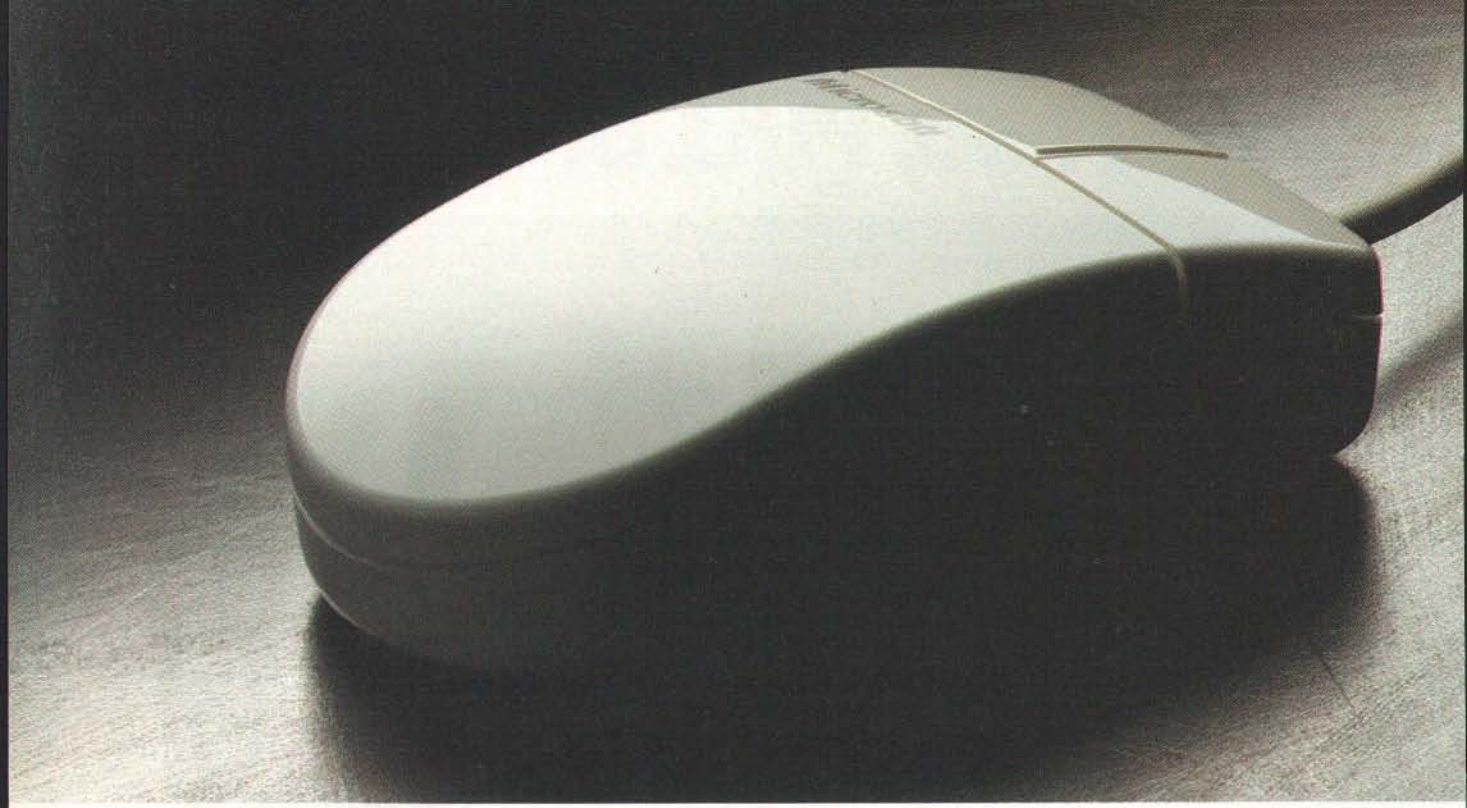

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Networking

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It began with the "old boy" network—business friends getting together socially and doing a little business on the side. And then it spread. Now, networking has come to encompass all those business and social contacts you can rely on for information, both within the context of your job and "without." (If you're suddenly "without" a job, you can usually rely on them to help you find a new one.) Regardless of how you are connected with people, they effectively end up as part of your network. At least that's the connotation the word has come to have.

Networking with computers has had a similar life cycle. It began with LANs and the communications that they enable. Now it's expanded to global proportions. Growing a LAN and interconnecting it with other LANs, wide-area networks, and metropolitan-area networks to expand its scope are complex tasks. Bill Catchings and Mark L. Van Name explore the challenges in managing such a network in "Growing Pains." One such growing pain we can all expect to face in the coming years is GOSIP, the government's new procurement profile. Sharon Fisher examines it and the effects it will have in the text box "The Latest GOSIP."

As some people are expanding their LANs, others are just starting out. They don't yet need the advantages of a full-fledged LAN, but they do need to network. Recent improvements in zero-slot LANs (ZSLs) can bring low-cost networking to the small business. Janet J. Barron describes this type of peer-to-peer network in "Want to Catch Some Z's?"

One networking solution that is coming out of the small office and into larger application is the wireless LAN. As the ZSL avoids giving up one of its slots to a network card (hence the name), wireless LANs avoid the whole question of what kind of cable to use. They also provide flexibility and portability in configuring your network, advantages that traditional LANs don't provide. "On the Radio" by Sorin Davidovici leads you through the intricacies of the wireless world.

You can grow a network in many ways. One of them is to increase communications speed. At the same time, you can make data more secure from eavesdropping if you switch to fiber-optic cabling. Expensive, you say? Not if you do it a bit at a time. Some of the improvements in communications expected in the coming years will even require it. In "Need More Fiber?" Sharon Fisher looks at these improvements, some of which are already in place. Two of them, high-definition TV and broadband ISDN, are discussed in more detail in a related text box, "On the Threshold of a Dream," by Richard Jay Solomon.

No matter what size network you have, you'll want to get as much out of it as you can. One way to do that is to fine-tune its method of allocating resources. One approach to resource allocation uses AI techniques to hone its decision-making skills. In "Primed for Performance," Tad Hogg discusses this approach and the balance required to make the most of the resources available.

I used to think that calling a group of business and social contacts a network was stretching things a bit. I don't anymore. The more I know about computer networks, the more I see the similarities. Now, if we can just bring the level of communications between people up to the level computers have reached. . . .

—Jane Morrill Tazelaar
Senior Editor, State of the Art

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Growing Pains

Sherman thought war was hell; he never had to expand a LAN

Bill Catchings and Mark L. Van Name

Remember when the toughest question that you faced concerning LANs was whether to buy one? Well, buying a LAN is kid's stuff compared to the problems you can encounter trying to expand it and connect it to other networks. As LANs have become vital to the everyday operations of more and more organizations, managing their growth has become a prime concern.

You can expand a LAN in two basic ways: by adding more users to a single LAN, or by linking stand-alone LANs into a larger network. Either method can tax your patience and your pocketbook, but you can ease the pain if you understand the issues involved.

ILLUSTRATION: MACIEK ALBRECHT © 1990

Peer Pressure

Many options are available if you want to enable a single LAN to handle more users. Which option you choose depends largely on whether you're using a peer-to-peer or a server-based LAN.

A peer-to-peer LAN, like CBIS's Network-OS or Sun Microsystems' TOPS, basically lets everyone share everyone else's resources. Your office mate could be using the printer attached to your PC, while you might be copying files from a third person's hard disk. Every machine is equal.

The biggest strength of peer-to-peer LANs is that they let you keep your systems physically pretty much as they are. You don't have to move any printers to a special system, nor do you have to store files in any particular spot; everything can stay just as it is. For this reason, peer-to-peer LANs are often attractive when all you need to do is link a few microcomputers.

However, most organizations that need to put a lot of users on a LAN don't choose peer-to-peer LANs. The biggest reason is that, while a peer-to-peer LAN lets you keep your hardware as is, it makes you change the way you work. Consider performance: You have to sacrifice CPU cycles on your machine to support anyone who wants to use a resource on it. (No one wants their system to be the one running the database that everyone else needs to use.) You can't just turn off or reboot your system anytime you want, because someone else might be using it.

There's also an organizational problem: It can be difficult to keep track of which systems' hard disks have the files you need. Many peer-to-peer LANs also have built-in limits on the number of users. Network-OS LANs, for example, typically have a 32-user limit.

For these reasons, most organizations that expect to need to support many users use server-based LANs instead of peer-to-peer systems. If your peer-to-peer

continued

configuration is getting unwieldy, you may be forced to divide the LAN into two or more smaller ones, or take the expensive and disruptive step of migrating to a server-based network.

Service with a File

Server-based LANs, such as Novell's NetWare, Microsoft's OS/2 LAN Manager, and Apple's AppleShare, dedicate one or more computers (the servers) to the task of providing services to the other computers (the clients) on the LAN. The most common services are printing, file sharing, and communications.

Whatever the service, the model is always the same: A client computer requests a service, and the server complies. The client and server roles are distinct and unchanging.

Server-based LANs solve the organizational problems of peer-to-peer LANs because all shared resources are on the servers. They also let you go about your business much as before, because no one but you is counting on using your system.

Server-based LANs also usually handle many more users than peer-to-peer LANs, but they, too, have some bottlenecks that can trip you up as you increase the number of users. Which bottlenecks you encounter depends primarily on how you use the LAN.

Bandwidth Marches On

One of the most common bottlenecks is the bandwidth of the LAN media itself. Some LAN technologies run at fairly slow speeds. Apple's LocalTalk, for example, operates at only 237,000 bps. It doesn't take many Macs to consume that bandwidth.

The most common PC LAN technologies run faster than LocalTalk: ARCnet clocks in at 2.5 megabits per second, traditional Token Ring at 4 Mbps, and Ethernet at 10 Mbps. These technologies let you add more users to a LAN than LocalTalk, all else being equal. Still, if you have enough machines sending and receiving data over any of these LANs, you can bring them to a halt.

One solution to the bandwidth bottleneck is to migrate to a faster version of your LAN. IBM has been shipping its 16-Mbps version of Token Ring for over a year now, and a 20-Mbps version of ARCnet is in the works. You can even increase LocalTalk's speed to 770,000 bps by using TOPS's FlashTalk. Only Ethernet users have no compatible upgrade path.

In the future, you probably won't look to any of these wire-based solutions to increase the bandwidth of a LAN. The future belongs to fiber-optic cables. For example, an emerging fiber standard, the Fiber Distributed Data Interface, boasts speeds of up to 100 Mbps. FDDI and other fiber technologies (see "Need More Fiber?" on page 233) will greatly alter the way we think about network bandwidth.

Although fiber is the LAN technology of the future, it nonetheless has some important uses today. For one thing, it is far less susceptible to electrical interference than are other types of cabling. For that reason, fiber is good in places like electrically noisy manufacturing floors or elevator shafts, or lightning-prone outdoor locations where traditional cables are vulnerable. There are LAN products available today that can run on fiber. DCA/10Net, for example, currently sells boards that run the Ethernet protocols over fiber-optic cabling. With these products, you can use the media you'll

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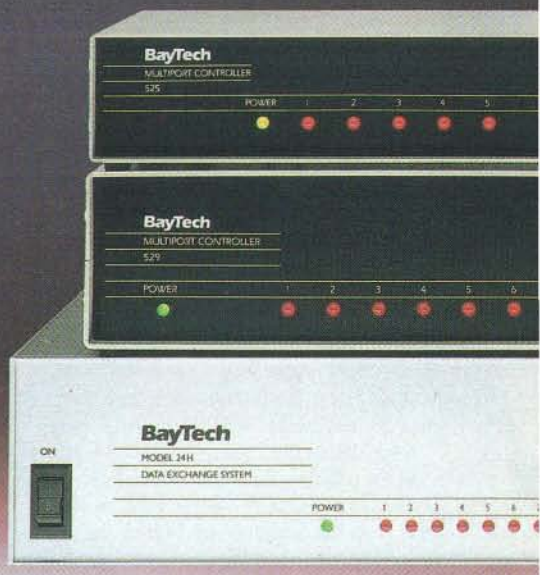

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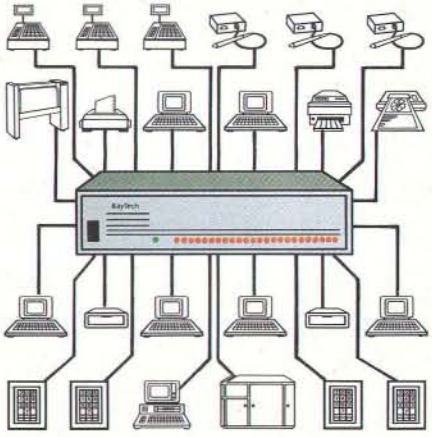

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Stretching Your LAN

LocalTalk, Ethernet, Token Ring, and ARCnet are all wire-based technologies. Even if you have the bandwidth to add more users, you can run into another fundamental limitation with any one of them: Their cables will reach only so far.

Take Ethernet, for example. It has a limit of 500 meters per cable segment. That may seem like a long way, but running a cable around an office building can consume that much cable quickly. Fortunately, you can get around this limit by using repeaters.

A repeater is a device that repeats the signal it receives from one LAN segment onto another. Ethernet's 500-meter limit is an electrical one based on the maximum distance that a single station's signal will travel. A repeater boosts that signal and, therefore, extends the limit. Repeaters are also nice because they are invisible to all higher-level hardware and software.

However, you cannot use an endless string of repeaters to extend an Ethernet LAN as far as you want. Ethernet sets a maximum time that a signal can take to reach from the node on one end of a network segment to the node on the other end. This maximum time limits the length of any network segment to 2500 meters. You can therefore use, at most, four repeaters in a line. You can use other repeaters in different spots in a LAN, but you can't have any loops or end-to-end distances greater than 2500 meters. Distance limitations vary among networks—you should check out the physical limits of your network.

Sometimes distance is less the problem than the difficulty or cost of laying the cable. In such cases, a wireless LAN might be the answer. A wireless LAN sends its data over an FCC-approved limited radio frequency spectrum. Instead of using cables, you connect each system, including the server, to a radio transceiver box.

Wireless LANs aren't quick—the fastest run at around 500,000 bps, and some are slower. They also don't work much over a couple hundred feet. Still, they can sometimes work where nothing else would.

Turbocharging Your Server

Not all bottlenecks on a LAN are due to the underlying media. Another common bottleneck is the server. Its capacity and speed are the two biggest factors in the growth and performance of many LANs.

The most obvious way to get more out of a server is to use a faster CPU. A 286 machine might be fine for 20 or 30 users, but bigger networks require more horsepower. Today, the 386 is the server processor of choice, and i486-based servers are growing in popularity. The user limitations of different versions of Novell NetWare demonstrate the effects of CPU power: NetWare 286 has a 100-user limit (which you'd be lucky to reach before saturating the network), while NetWare 386 can support 250 systems, as Novell demonstrated most recently at the NetWorld '90 show in Boston.

The 386 and i486 also offer more than just processing speed: Their architectures are much better suited to the life of a server than the 286's. They provide larger address spaces, better memory management, and 32-bit buses to speed data transfers. Novell and other LAN

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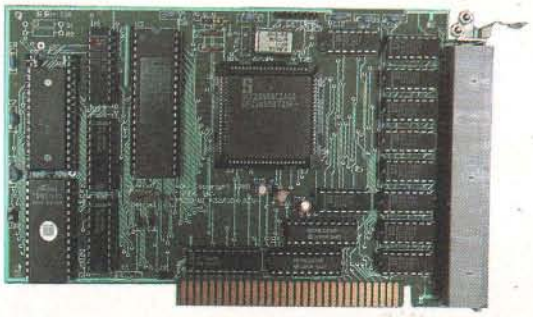

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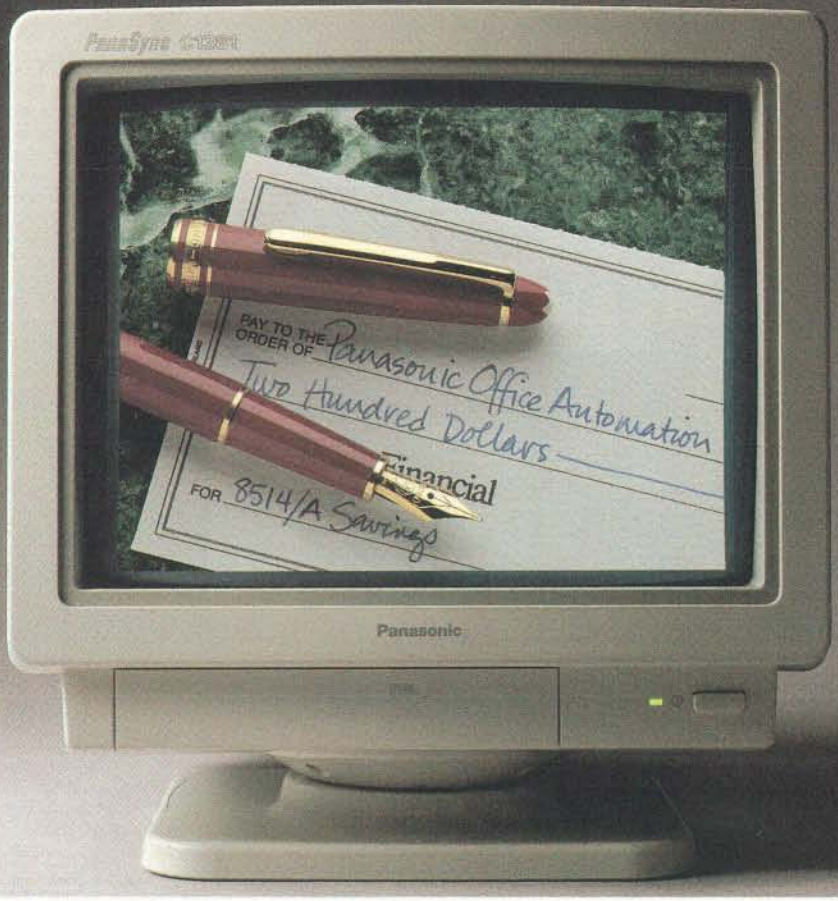

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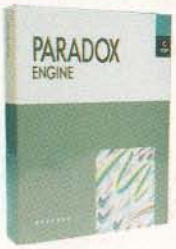

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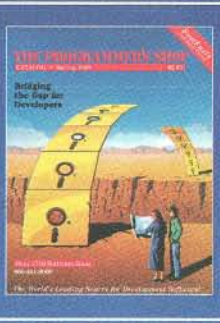

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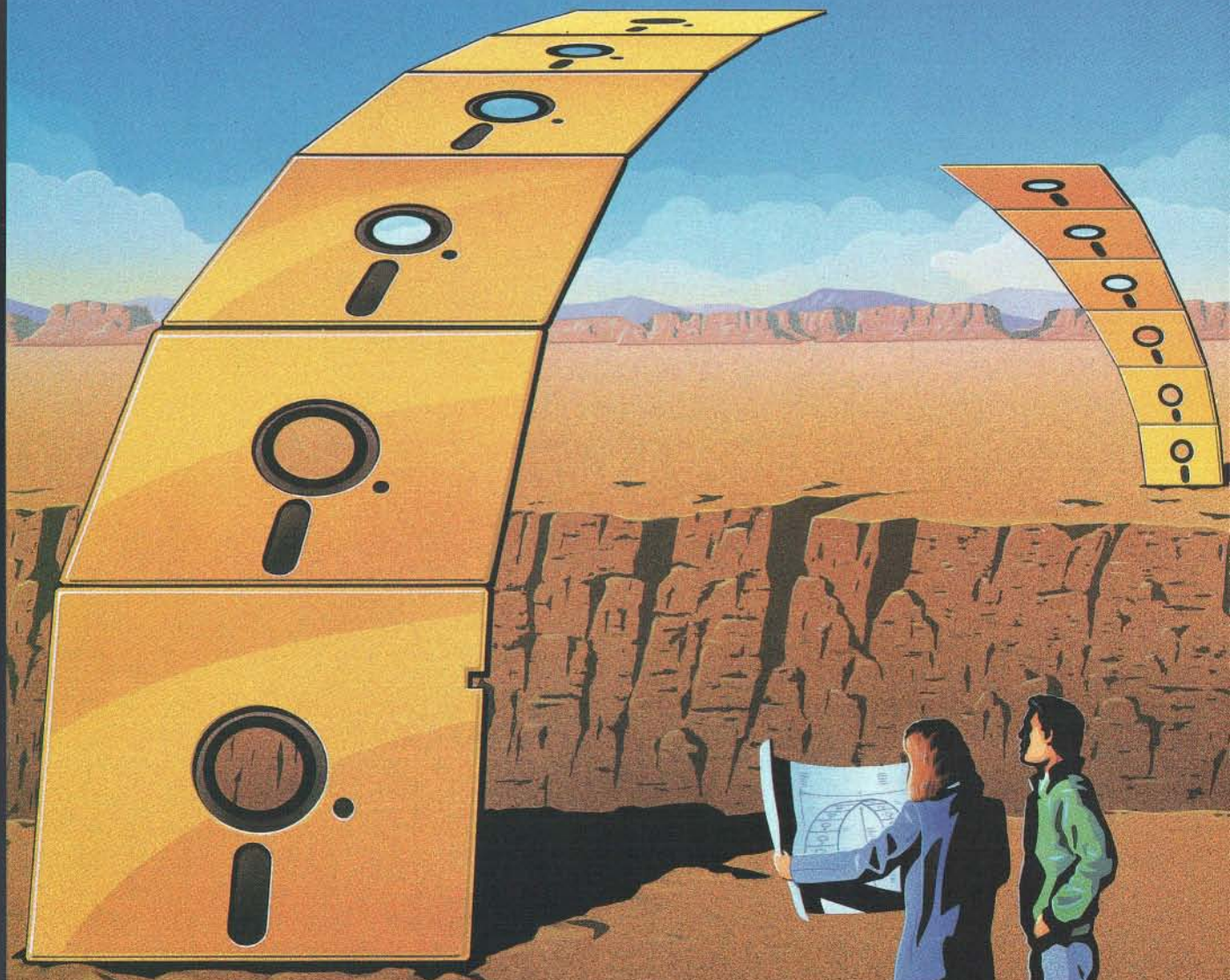

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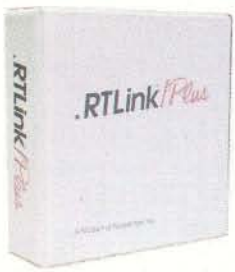

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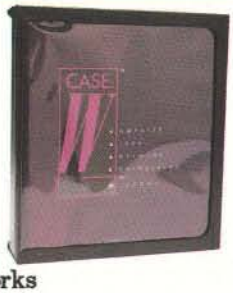

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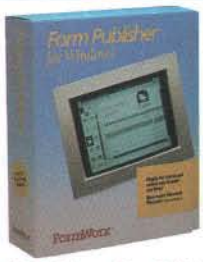

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companies are bringing out versions of their LAN operating systems that take full advantage of these architectural features.

The next step in server processing power is multiprocessor systems. Compaq, for example, plans to offer a two-processor version of OS/2 LAN Manager that will work with its dual-processor Systempro.

A faster processor alone, however, is never enough. The rest of the server system, particularly the disk drives, must be fast and large enough to keep pace with the CPU. Many of today's servers can hold over a gigabyte of disk storage, and average access times are falling below 10 milliseconds. Intelligent, caching disk drive controllers, such as Distributed Processing Technology's SmartCache, are improving those times even further. And finally, new technologies like the Intelligent Drive Arrays in the Systempro and the position-sensing disk drive controllers from Zenith Data Systems supply both improved speed and capacity to overburdened servers.

Of course, the fastest processor and disk drives won't do you much good if the data from the server trickles out to the LAN. Today's common, dumb, 8-bit network adapters just won't make it. To get the most out of a server, it should have a 32-bit bus that can support intelligent, 32-bit disk drive controllers and LAN adapters. Bus-master adapters—boards capable of taking over the bus—offer the best performance.

A Staff of Servants

You can support a lot of users with the right media and a single, high-end server. If you find that one server doesn't keep up, however, you'll have to investigate multiple servers. Most LAN operating systems can handle more than one server, but the move to multiple servers poses some special problems.

The biggest problem for most people is simply keeping track of files. It's nice to be able to store files on several servers—until it's time to remember where those files are. You also have to remember which printers are connected to which servers.

A LAN operating system can help with these problems, although the quality of support in this area varies widely. NetWare, for example, leaves you on your own (although an upcoming version promises some aid). Banyan's VINES, by contrast, shines in this area. Its naming services let you work only with symbolic names and leave the bookkeeping details to the LAN administrator. The printer you use may be named "Laser1"; that's all you need know about it. The administrator tells VINES what that name means.

Using several servers can also make it harder to log onto a LAN: You might have to log onto every server you want to use. Some LAN operating systems are improving in this area. LAN Manager 2.0, for example, simplifies this task by using a concept known as *domains*. A domain is a set of servers that behaves like one logical server. The servers share the same database of user IDs, so you need only one ID and password to use the resources on all the servers in the domain.

The biggest problem with multiple servers is simply keeping track of files.

Who, What, Where?

Multiple servers let you support many users, but they can also add administrative work. Every server is one more system to manage. Domains can help somewhat here, because they let you manage groups of servers largely as if they were one. Emerging standards for network management, such as the Simple Network Management Protocol, offer even better prospects for managing networks.

Of course, there's a lot more to managing a large LAN than just setting up user IDs. One crucial issue is, as always, performance. As a LAN gets larger, the number of possible bottlenecks grows, as does the difficulty of finding those bottlenecks. Problem diagnosis is crucial. One faulty network adapter or one workstation with the wrong version of the LAN operating system can sometimes bring an entire LAN, serving hundreds of users, to its knees. The best solution is to have good diagnostic tools. The Network General Sniffer, for example, can show you the traffic on the network so you can see which systems are causing the problems.

The Dance of the LANs

LAN growth problems don't stop within the confines of a single LAN. As more and more organizations are realizing every day, no LAN is an island—or, at least, no LAN should be an island. It's often not enough anymore just to make your own LAN work; you also have to hook it to other LANs in your organization.

You can link LANs with a wide array of products. Most of these products fall into one of three classes: bridges, routers, and brouters (see figure 1).

Bridges work closer to the LAN hardware than any of the other LAN-spanning products. Basically, a bridge takes packets from one LAN and puts them on another LAN. It is more than a repeater, because it knows enough about the signals it receives to spot the packets. It does not, however, know anything about the structure of those packets. A bridge doesn't care whether you send it information packets from NetWare, LAN Manager, or TCP/IP; it just faithfully passes the packets along.

This ignorance goes both ways, because bridges, like repeaters, are invisible to higher-level software. As far as the LAN operating system is concerned, all the LANs you connect with bridges are just one big LAN.

A *router* operates at a higher level than a bridge. A router understands not only what a packet is, but also enough of its structure to figure out the packet's destination. That information lets a router make decisions about how and where to route the packets it receives (hence the name).

A router greatly reduces the amount of unnecessary traffic between linked LANs because it only passes on packets from one LAN that are important to the other. Broadcast messages, for example, are usually best kept to the originating LAN, as they often don't matter to the other LAN. A router can also choose the best available path between two points in a complex network that has redundant paths between LANs.

The cost of this knowledge is that a router has to understand a specific protocol before it can route packets that obey that protocol. Routers are thus protocol-dependent, although some can route several different protocols. The routers from Cisco Systems, for example, can work with over 10 common protocols, including NetWare's IPX, AppleTalk, and TCP/IP.

The line between routers and bridges is rapidly blurring. Routers are being expanded to understand more protocols so they can compete with bridges. Bridges, meanwhile, are being improved so they perform some functions of a router—but

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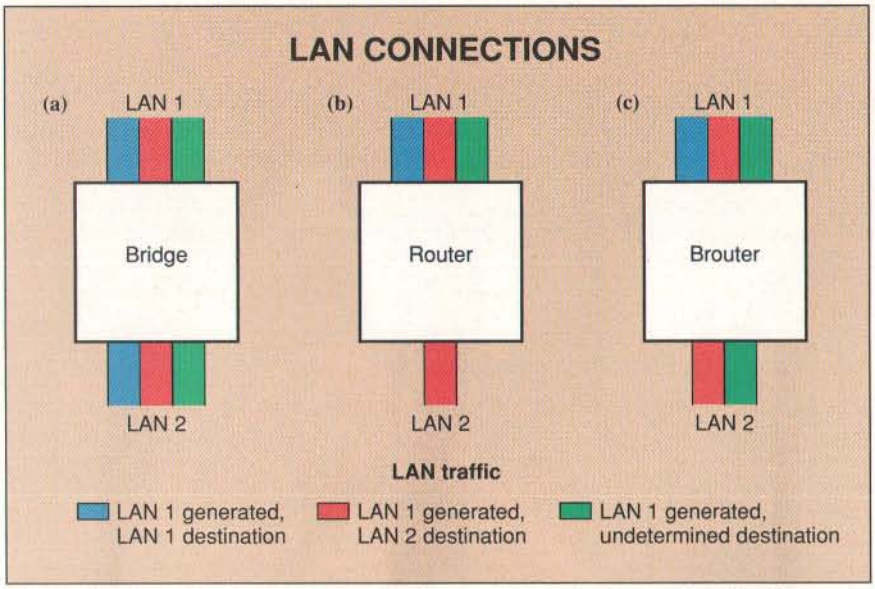

Figure 1: (a) *Bridges are high-speed LAN connections that pass all traffic from one LAN onto another.* **(b)** *Routers are slower than bridges, but they pass on only the packets that are destined for the second LAN.* **(c)** *Brouters act as routers for packets they recognize, and as bridges for packets they don't recognize. (Note: The figure shows only LAN 1–generated traffic; LAN 2–generated traffic is handled in an analogous manner.)*

at the higher speed of a bridge.

Further, a new hybrid, the *brouter*, offers some of the best features of both bridges and routers. A brouter routes the packets it understands, and it bridges the ones it does not.

The Long and the Short

Bridges, routers, and brouters can link LANs that are in close proximity as well as LANs that are far apart. Each situation has slightly different requirements.

To connect two distant LANs, you need two LAN-spanning devices and a phone line (or equivalent) to link them. You can use normal dial-up telephone lines, but their relatively low maximum speed makes them generally too slow for LAN linkage. Most linked LANs use at least a 56,000-bps leased line, and T1 connections (which run at 1.5 Mbps) are increasingly common.

To connect two local LANs, you need only one LAN-spanning device. Connecting more than two LANs, however, can get tricky because then you need to figure out which pairs of LANs to tie together. Every time you send a packet between two LANs, it has to travel through all the LANs between its source and its destination. It's a good idea, therefore, to locate LANs that have a lot of traffic between them close to one another.

Of course, pairing up LANs isn't always possible when traffic is more evenly distributed. If you have a lot of traffic between many different connected LANs, the best answer may be a *backbone*.

A backbone is basically a LAN whose only purpose is to connect other LANs. You link every LAN (with a bridge or router as usual) to the backbone. Thus, you only have one LAN—the backbone—between any pair of LANs. Each LAN communicates with the others via the backbone.

This approach is great for the individual linked LANs, but it obviously can place a huge burden on the backbone, which must carry all the packets that move between LANs. Because of this high performance requirement, backbones often use different technologies than the LANs they connect.

One common backbone technology is broadband, which is basically the technology used for cable TV. Broadband, as its name implies, can carry more traffic than can such baseband technologies as Ethernet or Token Ring. Broadband has many channels, each of which can carry different types of data. Broadband can also span physical distances of up to 30 kilometers, which makes it a good way to link several buildings or even an entire corporation or university campus.

Fiber is emerging as another good backbone technology. Fiber cables need repeaters if you run them more than a few kilometers, but their large bandwidth lets them handle a great deal of inter-LAN traffic.

LAN-Spanning Complications

While bridges, routers, backbones, and the like are able to provide the bandwidth needed to link multiple LANs, they can't link LANs that use incompatible technologies. Your engineering department's LAN might use Ethernet, while the accounting department uses Token Ring. You need special bridges and routers to link such dissimilar LANs. Ethernet and Token Ring, for example, both use the same Logical Link Control protocols (IEEE 802.2), so bridges and routers between the two must understand the LLC protocols.

Sharing the same LLC protocols often isn't enough, because the LANs you want to link may be running different higher-level network software or protocol stacks. For example, LAN Manager on Token Ring works with a NetBEUI protocol stack, while LAN Manager on Ethernet may use a version of IPX. Even though they use the same operating system, you'd need more than a bridge or router that understands LLC protocols to get these LANs to communicate.

The problem is even worse when you are running two different network operating systems on the LANs you want to connect. Basically, you're on your own here. Whether you're trying to connect LANs that use NetWare, LAN Manager, or the Unix-based Network File System, the mechanisms for linking such highly dissimilar LANs are still up in the air.

Living on a Network of Networks

Once you've connected all the LANs and gotten everything working, you often find that you've got all the same problems that you had with a single LAN, but on a much bigger scale. Finding the printers and files you want can be hard enough with multiple servers on a single LAN; on multiple linked LANs, it can be a nightmare. Obviously, in this environment, such concepts as domains and named services can be vital.

Network management also becomes much more complicated when you have several linked LANs. Not only must you manage the systems on each individual LAN, you also have to worry about the bridges, routers, and phone connections between them. Spotting bottlenecks and failures in a complex network can be a monumental undertaking. Network management systems, such as IBM's NetView, can help somewhat, but often many components of complex networks

continued

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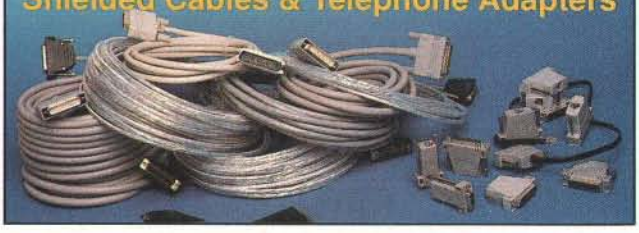

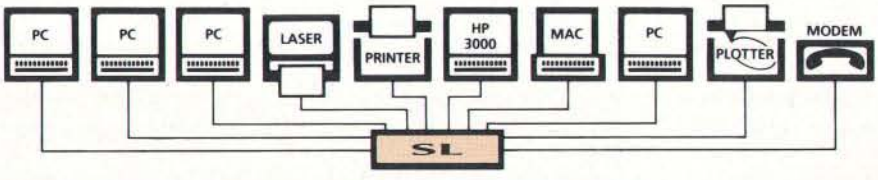

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The Latest GOSIP

Sharon Fisher

It's been said that the federal government runs on gossip, but starting in August, that will actually be true. Government agencies will be required to specify communications products that support the Government Open Systems Interconnection Profile, or GOSIP, in new procurements and major upgrades.

If you think that doesn't apply to you, you're wrong. All companies that sell to the government will be required to comply with this standard. Over time, it may well become cost-effective for those companies to support only one standard—GOSIP. Sooner or later, it will affect us all.

What's the Story?

To understand what GOSIP is, you need to know what Open Systems Interconnection is. OSI is a set of communications protocols developed by a group of international users and vendors. Unlike some other communications protocols, OSI is not proprietary; no vendor has control over it. Instead, it's controlled by international organizations such as the International Standards Organization (ISO) and the CCITT.

The point behind developing the OSI standards is to get away from proprietary protocols to allow users to buy systems from different vendors and have them communicate without having to go to a lot of effort. Nearly every major vendor (including IBM, DEC, and Hewlett-Packard) has committed to supporting OSI protocols at some time in the future. However, some vendors haven't been specific about how they're going to do that.

The problems now are that so many protocols have been grouped under the OSI banner that a single product cannot support them all, and that some user organizations don't require them all. That's where profiles come in. OSI profiles, such as GOSIP, are defined by user organizations or governments and consist of a subset of the OSI protocols that the organization says it will use. GOSIP is the OSI profile defined by the U.S. government (see figure A).

Getting Down to the Nitty-Gritty

GOSIP is actually a series of profiles, not just one. Version 1 was promulgated as a federal information processing standard in August 1988. It went into effect in February 1989, at which time its use was encouraged. It becomes mandatory in August of this year.

In other words, prior to the mandatory date, federal government users should *try* to request GOSIP support in their proposals, and vendors are *supposed* to develop products that comply. After August, government users *must* specify products that support GOSIP protocols, if they exist.

Microcomputers, however, don't necessarily have to support GOSIP. It's only required for "host" systems, and microcomputers are generally thought of as "local" systems. They can support GOSIP themselves or provide GOSIP functionality through links to a minicomputer or mainframe. For example, you can remotely log onto a minicomputer to read OSI-compliant E-mail or download files obtained through OSI-compliant file transfer protocols.

The main features that GOSIP 1 specifies are the ability to send and receive E-mail using Message Handling Systems (MHS, also known as X.400), the OSI E-mail standard, and the ability to access and transfer files using File Transfer, Access, and Management (FTAM), the file transfer standard.

In addition to basic file transfer, FTAM has several options, such as reading and writing from indexed files, locating and erasing data from indexed files, retrieving complete information on file-storage properties, retrieving file-security properties, and sending and receiving file-directory information.

GOSIP specifies six FTAM implementation profiles:

- T1—simple file transfer
- T2—positional file transfer
- T3—full file transfer
- A1—simple file access
- A2—full file access
- M1—management

All FTAM systems must support at least T1; depending on the function, you can also specify the more complex profiles.

For network technology, GOSIP version 1 supports IEEE 802.3 (Ethernet) over baseband or broadband, IEEE 802.4 (token bus) over 10-megabit-per-second broadband or 5-Mbps carrier band, IEEE 802.5 (Token Ring), and 1984 X.25 packet-switched networks. Physical-level specifications (e.g., RS-232C versus V.35 for X.25 connections, or fiber versus twisted-pair wiring for IEEE 802.3 connections) are not specified, giving you some flexibility in your requirements.

You can also provide these network technologies via others, such as by linking an IEEE 802.3 network to a digital private branch exchange and transmitting the data over the telephone lines, or by using X.25 interfaces and terminal adapters to link to ISDN.

In addition, GOSIP specifies the use of the Connectionless Network Protocol (CLNP) to provide a reliable end-to-end data path between networks. This protocol masks the differences between the network technologies, allowing several LANs to interoperate. It also includes features that limit the number of hops a message can take and the amount of time it takes to reassemble a message, to keep loops from occurring in the network. GOSIP doesn't directly specify LAN bridges, so they can also be used.

Over the CLNP is the Transport layer, which consists of five classes of increasing levels of capability with respect to retransmission of lost data, flow control, and reordering of packets. GOSIP specifies TP 4, the highest level of capability.

GOSIP does not specify programming interfaces or user interfaces. This means that programs can't necessarily be moved from one computer to another and still work, nor will all GOSIP-compliant products have the same look. Instead, GOSIP support can be added to existing products. Thus, you don't have to learn a new way to send E-mail—just, perhaps, a new way to address it, using MHS addresses.

Things to Come

GOSIP 2 is due to be specified this month, with version 3 to come about 15 months later. Each will go into effect about 18 months after specification. The organization that decides which protocols to add to the GOSIP specification is the intra-agency GOSIP Advanced Requirements Group in Gaithersburg, Maryland, chaired by Jerry Mulvenna.

Version 2 adds support for the Virtual Terminal application and ISDN as a new network technology. VT allows terminals or microcomputers to log onto other systems without needing to know their specifics.

The following services are expected in later versions of GOSIP:

- *Transaction processing.* An Application layer protocol that allows you to enter groups of related data into a database and retrieve the entire group should one transaction fail.
- *Secure Data Network Service (SDNS).* A set of services, such as authentication, access control, confidentiality, and integrity. Security services can be implemented at layers 1, 3, 4, and 7 of the OSI Model.
- *Dynamic routing.* Allows a network to pick the most efficient route from one system to another, based on factors such as congestion, availability, and cost. It includes two separate protocols: one between end systems and intermediate systems, and one between two intermediate systems.
- *Electronic Data Interchange (EDI, or X.12).* Can be supported as a mail-body type through MHS, a file type by FTAM, or a separate Application layer service.
- *Office Document Architecture (ODA).* Allows you to exchange two types of documents produced in an office environment: ones that contain just the logical structure (i.e., the contents), and ones that contain both the contents and the format.
- *Network management.* Consists of three parts: a set of protocols for exchanging management information, a structure for managed objects, and definitions for the objects and their attributes.
- *Directory services (also known as X.500).* Stores and retrieves information about objects in an OSI environment, along with attributes such as E-mail address, postal address, and telephone number. X.500 could also provide browsing capabilities and a "yellow pages" service.
- *Additional features of existing GOSIP protocols.* For example, FTAM will support simultaneous reads and writes, the ability to search directories, and specification of different levels of access control on portions of the same file. Future versions of MHS may allow security features such as message-originator authentication, checks against unauthorized disclosure, and verification of content integrity; support for directory services; and message store delivery, which would allow microcomputers to use MHS services without having to support MHS themselves.

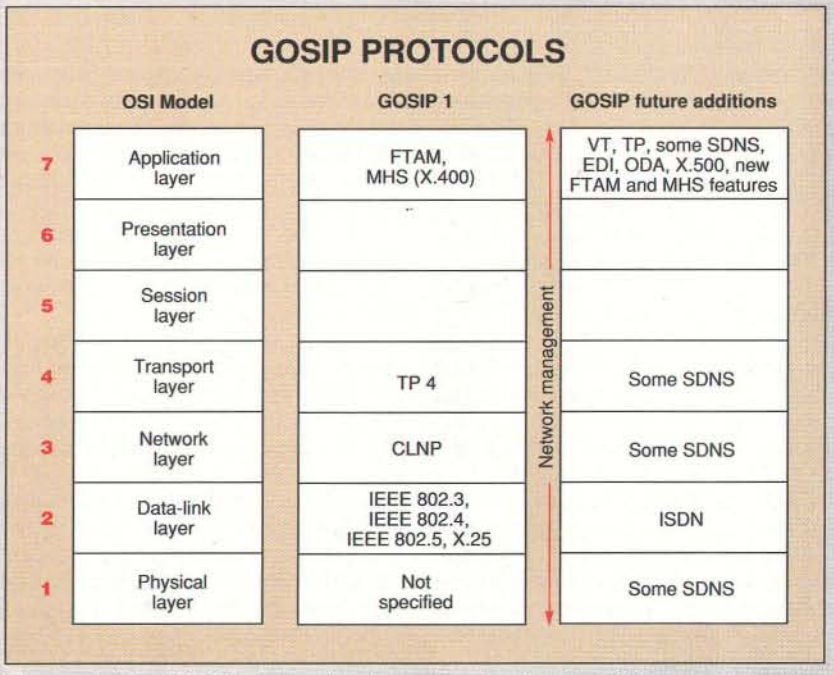

Figure A: *The GOSIP choices for the various levels of the OSI network model. Version 1 takes effect in August of this year. Future additions will probably begin to take effect sometime in 1992.*

Checking It Out

To ensure that different implementations of the OSI protocols are correct, several types of required and optional conformance testing are specified.

The mandatory testing is done with various testing programs, such as those from the Corporation for Open Systems in McLean, Virginia. As part of its COS Mark program, COS has been testing OSI implementations since April 1989. In December 1989, COS and the National Institute of Standards and Technologies (NIST, formerly the National Bureau of Standards) agreed to work together on testing GOSIP implementations. According to Vincent Roccanova, manager of the COS Mark program, this testing could take as little as a week.

Another form of testing is the test against a reference implementation, in which one vendor tests its product against another vendor's product, which is specified by NIST. This test is mandatory if NIST designates such a reference implementation, but it is not mandatory if the organization doesn't find a reference implementation of high-enough quality, says Roccanova.

The third type of testing is pairwise, which means that two vendors voluntarily agree to get together and test their products. If these voluntary tests work, the results go into a public record that NIST maintains, Roccanova says.

The Proof Is in the Pudding

Government agencies are required to begin specifying products supporting GOSIP protocols, when available, as of August 15 for new procurements or "major upgrades," an undefined gray area. This is deliberate, according to Mulvenna.

If you wish to use non-GOSIP products when GOSIP products are available, you must go through a waiver process and have some sort of gateway to interoperate the new and old products. Waivers are supposed to be allowed only when compliance would make it more difficult for a federal computer system to accomplish its mission, or if the cost of GOSIP compliance would offset the amounts that the rest of the government expects to save.

But you can't move to GOSIP until vendors ship products supporting its protocols. While a number of products are available now, Roccanova expects many more by August, noting that vendors will probably time their announcements to coincide with the adoption of the GOSIP requirements.

Sharon Fisher is a San Francisco–based freelance writer specializing in computer communications. She can be reached on BIX as "sharonfisher."

FURTHER READING

Government Open Systems Interconnection Profile Users' Guide, NIST Special Publication 500-163, NIST, 5285 Port Royal Road, Springfield, VA 22181. Copies of other OSI specifications are available from Omnicom, Inc., 115 Park St. SE, Vienna, VA 22180.

don't support these tools. This is obviously an area in great need of standardization, but progress is slow. For instance, the present version of the GOSIP standard (see the text box "The Latest GOSIP" on page 212) doesn't include network management protocols. Future versions, however, are expected to.

The Rest of the World

In most organizations, LANs aren't the only computing resources. Important data often resides on minicomputer and mainframe systems, and LAN users need access to that data. There are several ways that you can meet that need.

If the data is on an IBM mainframe, the LAN must learn how to translate its requests into the mainframe's protocol. Devices that perform such translations—whether they are between a mainframe and a LAN or between two dissimilar LANs—are called *gateways*.

The most common type of gateway is one that lets LAN workstations pretend to be mainframe terminals, typically some member of the 3270 terminal family. A 3270 gateway lives in a system on the LAN and connects that system to the mainframe. Any LAN system that wants to use the gateway sends information to the gateway system, which forwards it to the mainframe and transmits the mainframe's reply. A more powerful protocol for LAN-to-mainframe connections is LU 6.2, which lets microcomputer programs communicate with mainframe programs. Gateways that support LU 6.2 are increasingly popular.

Connecting a LAN to a minicomputer entails similar problems, although minicomputers are often already connected to their own LANs. The simplest way to access a minicomputer is via a terminal gateway, which can be as simple as a system with an asynchronous modem and a communications package. The gateway can also be a product that understands the minicomputer's LAN terminal protocol, such as DEC's Local Area Transport protocol.

Some minicomputers, such as DEC's VAX, can also support common PC LAN protocols. NetWare for VMS, for example, lets a VAX look and work like any other NetWare server. Many minicomputer companies plan to support LM/X (LAN Manager for Unix) on their Unix systems. Atlantix already sells software that lets Unix systems act as NetWare servers.

More to Come

Even with all the solutions available for setting up and connecting LANs, there is a long way to go before you'll be able to link transparently and manage different kinds of LANs. Still, if LAN users keep demanding such capabilities, the market is sure to respond.

If you use personal computers, you have been hearing about "The Year of the LAN" for most of the past decade. Well, the Year of the LAN has come and gone—although nobody knows for certain which year it was. With luck, the focus of the next decade will be on improving and maturing LANs and the ways you link them. That seems to be the current trend; let's hope it continues. ■

Bill Catchings and Mark L. Van Name are BYTE contributing editors. Both are also independent computer consultants and freelance writers based in Raleigh, North Carolina. You can reach them on BIX as "wbc3" and "mvanname," respectively.

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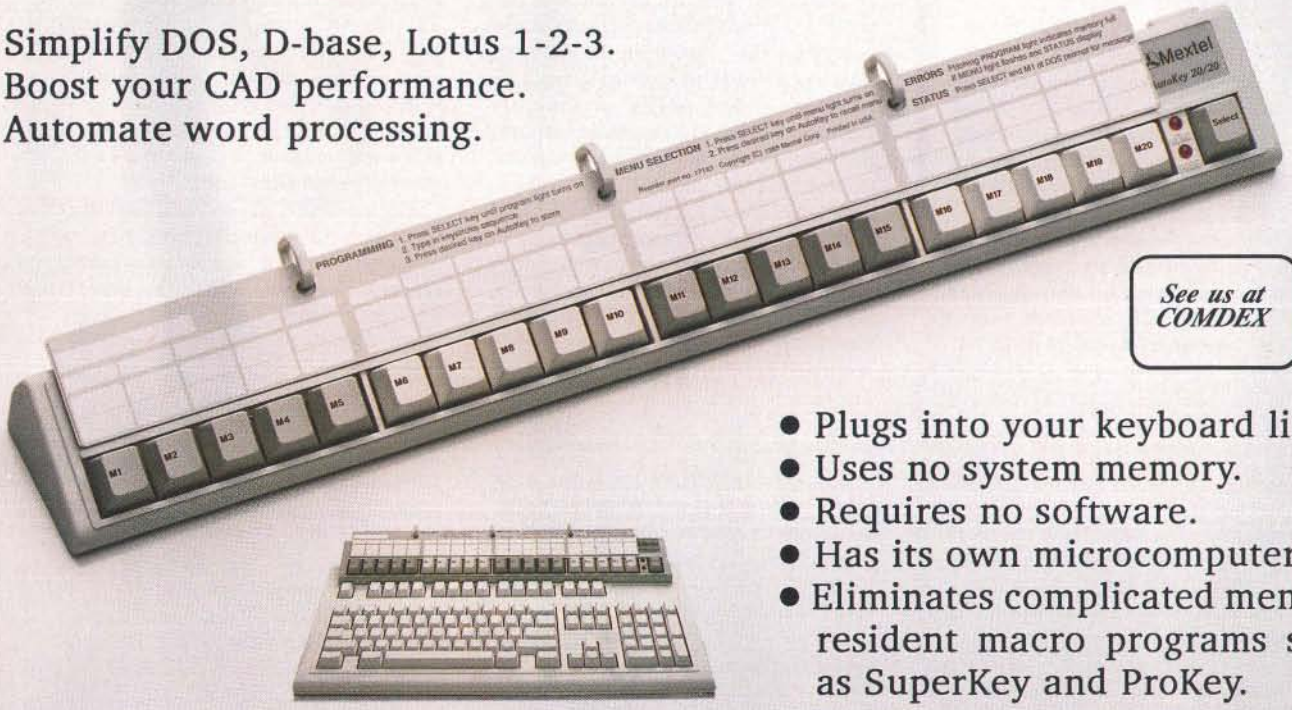

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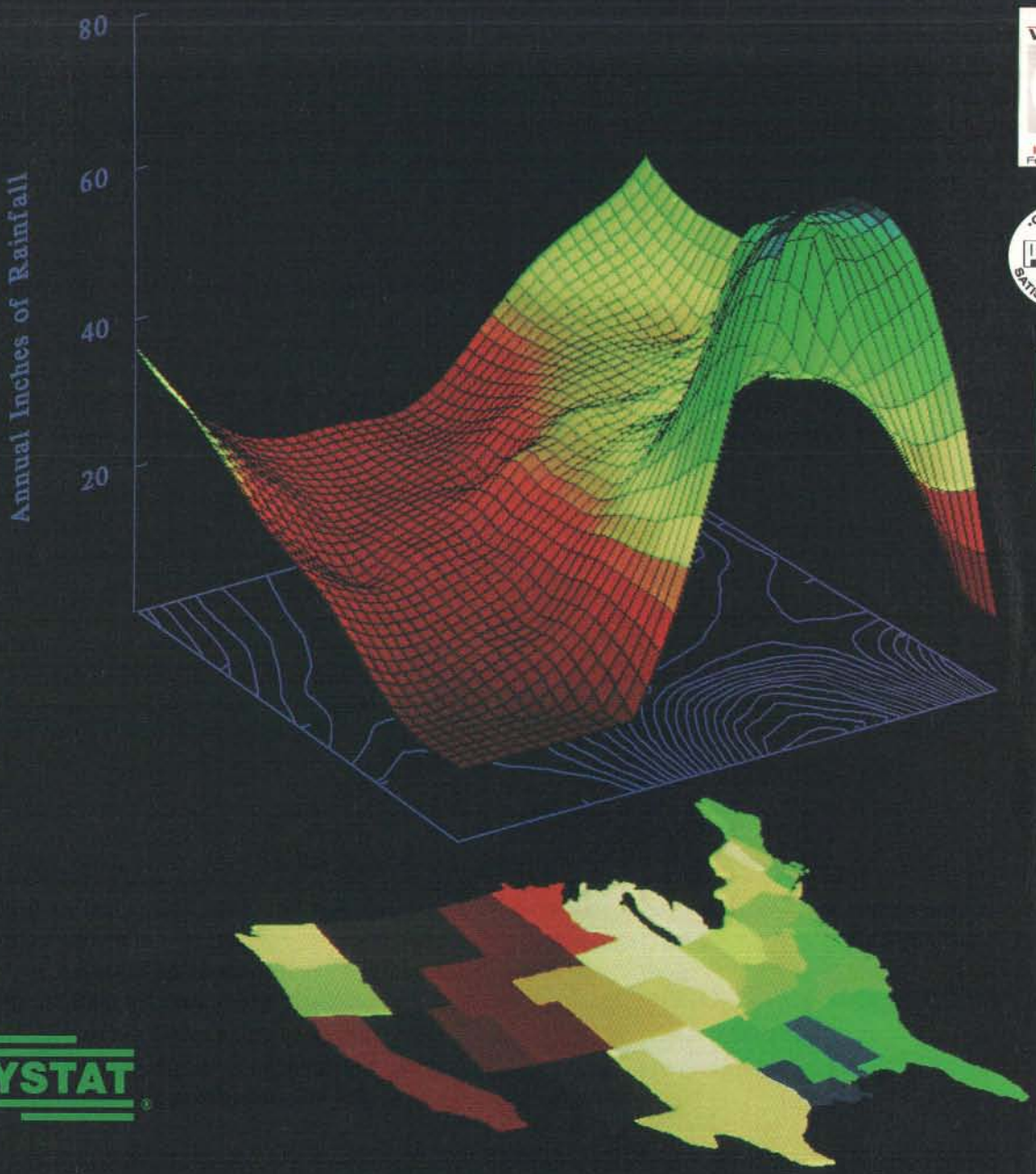

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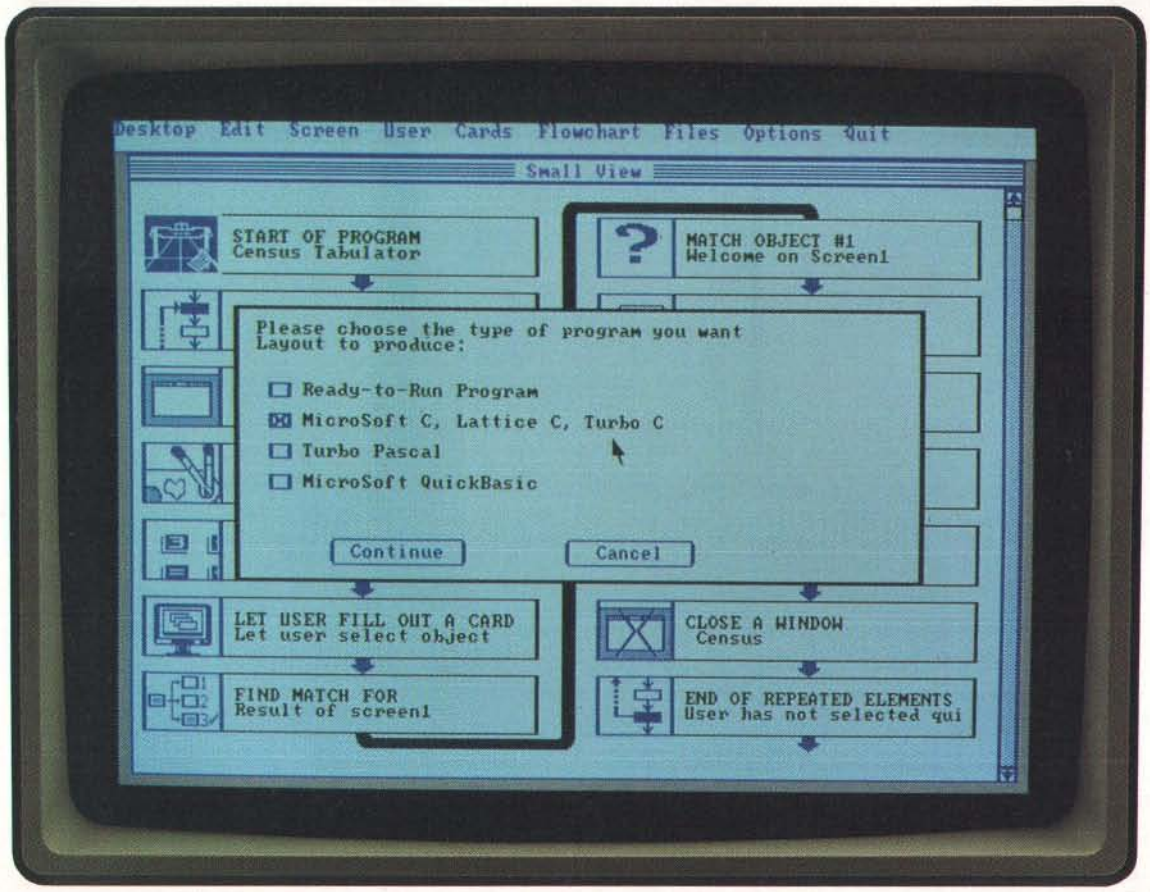

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Want to Catch Some Z's?

For many small networks, a full-fledged LAN may be overkill; that's where zero-slot LANs come in

Janet J. Barron

Zero-slot LANs are nothing new; they have been around for a few years now. But this type of peer-to-peer LAN now offers some additional intelligence and newly enhanced utilities. Because of these improvements, ZSLs qualify as a proven state-of-the-art option for those who need low-cost, easy-to-install and -maintain file transfer, peripheral-sharing, and file-sharing capabilities (see table 1).

A ZSL is so named because, instead of taking up one of your microcomputer's expansion slots, it can be plugged into a serial or parallel port. Such a peer-to-peer device easily connects computers and peripherals and inexpensively provides capabilities such as file transfer and sharing; drive and printer redirection, allocation, and optimization; automatic file backup; E-mail; print spooling; and other networking benefits. Peer-to-peer networks do not require a dedicated file server; they provide you with access to files on other users' hard disks.

ZSLs come in several forms. They can consist of intelligent hardware switches and adapters, software alone, or a combination of hardware and software. You can usually install one in a matter of minutes. It would take much longer to install a full-fledged LAN.

You can configure a ZSL in a star, ring, point-to-point, or bus topology. You can connect from two to about 30 nodes, depending on the ZSL, configuration, conditions, applications, and type of system. You can then daisy chain several of these work clusters together with currently available products.

A ZSL can cost anywhere from $75 per node to several hundred dollars per node (see table 2). You can get a basic ZSL for one-tenth to one-half the price of a larger, more powerful type of LAN—the installation costs alone for a full-blown LAN can amount to thousands of dollars. In addition, with a peer-to-peer network, you needn't dedicate an employee to maintaining the system—another benefit that adds to its cost effectiveness. (For some real-world examples, see the text box "Different Strokes for Different Folks" on page 220.)

Peer-to-peer networks are available with features that range from basic (i.e., simple file transfer and peripheral-sharing capabilities) to high-level (i.e., complex file sharing, ports that can be configured as either serial or parallel, software pop-up utilities with some buffer memory, and the ability to tie into other LANs and wide-area networks [WANs]). (For a review of low-cost peer-to-peer networks, see "Networks of Peers" on page 142.)

While the numbers vary widely, Pete

continued

ILLUSTRATION: MACIEK ALBRECHT © 1990

ZSLS VS. FULL-FEATURED LANS

Table 1: Typically, ZSLs provide fewer features than full-fledged LANs, but they also cost less and are easier to install and maintain. This table provides a quick-reference comparison of ZSLs versus high-level LANs.

ZSL	Full-featured LAN
Less expensive per node.	More sophisticated network features.
Easier to install and maintain.	More node capability and fewer node distance constraints.
Less node capability and more limited distances between nodes.	More speed and power for user applications.
Does not tie up computer's expansion slots.	Capabilities may exceed low-level users' needs but are necessary for more sophisticated users.
No need to dedicate one computer as a server.	Very difficult to move and reconfigure.
Provides sufficient capabilities for low-level users' needs but not enough high-level features for sophisticated users.	Considerable benefits for power users' graphics-handling and storage needs.
Easy to move and reconfigure.	Lightning-fast transmission.
Most are not powerful enough for power users' needs.	Efficiently links minicomputers, mainframes, and other LANs and WANs.
Even using a parallel port, speeds are still relatively low.	
Difficult to link to minicomputers, mainframes, and other LANs and WANs.	

Peterson, president of Digital Products, a zero-slot LAN firm, has some ballpark figures showing that about one-third of all networked microcomputers are connected via peer-to-peer or low-level LANs, as opposed to server-based LANs. If Peterson's statistics are accurate, these numbers show that a tremendous number of ZSLs (especially the new, higher-speed, increased-capability types) are in place and being used either by personnel in small firms or to connect the work clusters of larger companies.

An Infinite Variety

As the lines between microcomputers and workstations are rapidly disappearing, so are those between some of the latest feature-packed ZSL products and what used to be called "full-featured" LANs. With almost any product or technology that fills a need and gains a following, a variety of iterations (and names for those iterations) come down the pike and either confuse or clarify the issue. ZSLs are no different.

Peer-to-peer networks have various names and work in a variety of ways. Well over a dozen firms offer ZSLs. Among the names these firms use for their products are

- zero-slot LAN (LANLink 5X and 3X)
- sub-LAN (NetCommander)
- peer LAN (LANtastic)
- file transfer/resource-sharing software (ZeroNet, Brooklyn Bridge, and FastLynx)
- RS-232C network (EasyLAN)
- data-exchange system (Model 24)

as well as a variety of generic terms, such as peripheral-sharing devices and limited-function networks.

Regardless of what ZSLs are called, however, the choice of a ZSL still hinges on what you need a network for in the first place. If your primary applications fall into the areas of peripheral sharing, print spooling, automatic file backup, or shared data, you may find that a full-featured LAN is overkill. And if you tend to move devices around a lot or revise your file- and peripheral-sharing needs often, a ZSL may be your network of choice.

On the other hand, full-featured LANs are ideal for applications using multimachine, application-specific, fast data transfer, number-crunching, and graphics capabilities. You will also find a full LAN appropriate when your main requirements are sharing applications, databases, and expensive peripherals (e.g., hard disk drives and laser printers), and where graphics printing speeds are important. High-level LANs are also better if you need to link to minicomputers, mainframes, WANs, and other full LANs.

Another feature of ZSLs is that, in most cases, they are TSR programs—they run in the background. Thus, you don't need to dedicate an expensive machine to be used solely as a file server. In addition, ZSL nodes tend to be more resistant than high-level LAN nodes to system failures because, in a peer-to-peer network, each node essentially operates autonomously (it has its own in-place software and hardware).

Trading Places

Typically, ZSLs are the right solution for small installations where the applications are simple and not compute-intensive. But even in these situations, they are not always perfect solutions. Most users agree that ZSLs that use your computer's serial port simply don't provide throughput fast enough for true file sharing. And, as ideal as low-level LANs with high-speed parallel-port transmission may seem, they (and some of the add-ins designed to enhance their features) often have trade-offs.

Naturally, since most peer-to-peer networks are TSRs, you must deal with the usual RAM-resident disadvantages. If your ZSL and the applications you run over it all require a great deal of memory, you will experience a significant degradation in throughput. And, as with high-level LANs, the farther apart you place your networked nodes, the worse this situation becomes.

Also, especially with a ZSL, the more nodes you have, the more you will experience system degradation. ZSLs often have extreme constraints on how many nodes you can run. With some systems, you will experience optimal operating conditions with only two or three connections. In addition, most ZSLs have significant limitations on the number of microcomputer clusters you can daisy chain.

There are ways, however, to enhance a peer-to-peer network's performance. When you want to use a ZSL to connect multiple nodes to a single server while maintaining current printer ports, you can obtain an add-in board called the ParaPort for The SoftWare Link's LANLink 5X system.

With this PC-compatible four-port parallel expansion board, you can use parallel ports beyond LPT1, LPT2, and LPT3. In addition, you can install up to four ParaPort boards in your computer, providing a total of 16 parallel connections—each of which transmits at 500,000 bps. The ParaPort supports bidirectional data flow and lets each computer function as both a server and a satellite.

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Different Strokes for Different Folks

In Dallas, Texas, full-time attorney (and part-time computer aficionado) Bill Knight had a problem. He had purchased for his small company a laser printer and two computers—an XT clone and a portable. Besides carrying out billing duties, Knight's office personnel also spent lots of their time creating and printing (and later archiving) forms.

The secretaries had both machines tied up constantly (often redundantly) performing these tasks, leaving the attorneys unable to use them. In addition, when there was a need to print wills or other important documents, the laser printer was always busy on routine billing tasks.

Over the previous 2½ years, the computers and peripherals in Susan Post's Cambridge, Massachusetts, financial-planning office had gradually proliferated. Recently, Post realized that she and her associates had become overwhelmed trying to deal with the resultant tangle of wires. They were also frustrated by their inability to connect the company's four computers, laser printer, letter-quality printer, plotter, and communal files, which they all needed from time to time. She knew something had to give.

Knight and Post were stymied. They both had to find a way to address their needs with minute budgets, a minimum of technical expertise, and no funds to pay for even a part-time network person. In addition, the installation and maintenance time and effort that a full-blown LAN required intimidated both business owners.

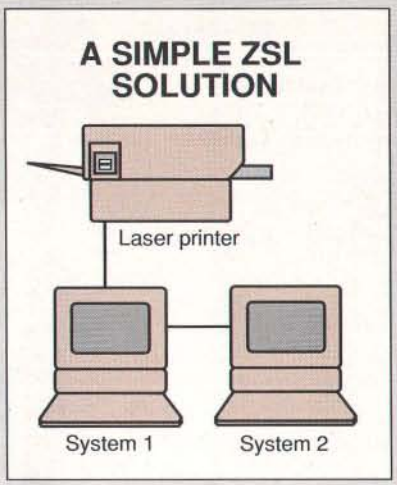

Figure A: *Knight chose a basic ZeroNet ZSL to connect his two computers and laser printer. He linked his computers with the cable and intelligent serial-port hardware adapters included with the system.*

A Many-Sided Solution

At about the same time, the attorney and the financial planner heard the term "zero-slot LAN." Independently of each other, they began to investigate this type of peer-to-peer network to see whether it might meet their needs. Eventually, both Post and Knight decided that a ZSL was what they were looking for.

Knight connected his two computers and laser printer with a simple station-to-station hookup using telephone cable and two intelligent hardware adapters that he plugged into his computer's serial ports (see figure A). He didn't immediately maximize the use of the ZeroNet system. But he knew he could expand the network (to up to 10 PCs) as he added more machines and memory-hungry peripherals.

Knight had the network up and running in about 10 minutes by connecting a 25-pin intelligent hardware adapter to each of his computers' serial ports and attaching the vendor-supplied cable's modular plug to the adapter. The laser printer was already hooked up to the first system's parallel port. He used ZeroNet's automatic program to install the ZeroNet software. At bootup, the software ran a setup program that defined the peripheral that his PC would share, as well as how he would access the laser printer and how the other computer's remote resources would map to his primary system.

Because Post had more sophisticated needs, she purchased a more complex ZSL system. She opted for a Software Link LANLink 5X network running single-user PC-MOS. To give all the machines access to the server, she installed a ParaPort in the server. A ParaPort is a four-parallel-port card that gives the machine a total of seven parallel ports, three of which you can use for standard print devices such as a printer or plotter. The other four you can use for network connections (see figure B).

Thus, Post obtained an expandable hybrid system providing file transfer, file-sharing, and program-execution capabilities as well as extra speed. With this scheme, she knew that down the road, she could add several new inex-

speaking, it is. But be aware that your computer does not see the ParaPort as a standard parallel port. Thus, if your machine has a ParaPort installed in its only parallel port, you can't drive a printer from it; you must use the port for a LAN. If, however, you have two parallel ports, you can run both a LAN and a printer.

Assuming that you don't need all the bells and whistles of a high-level, hardware-based LAN, a basic ZSL is less expensive and more easily installed and maintained. But if you want to connect more than four or five users on a simple peer-to-peer network or take advantage of the sophisticated benefits that full LANs offer, you'll have to add some system enhancements that run into money and increase the complexity of the network. As you add features to a ZSL, the price per node rises, and your system will soon come close to costing as much as a full-featured LAN that would provide you with more bang for the buck.

Growing by Leaps and Bounds

Advancements in peer-to-peer technology have kept pace with improvements in LAN technology as a whole. Some of the current ZSLs now furnish tremendously boosted speeds and automatic tape backups of each system machine. Other ZSLs provide enhanced graphics capabilities (e.g., the use of sophisticated printer fonts and cartridges) and ports to minicomputers and mainframes.

Many users can still comfortably meet their needs with a basic peer-to-peer network that plugs into their computer's RS-232C port and transfers data at 115,000 bps. However, in today's information-driven world, others think this

pensive ASCII or *unterminal* stations, each of which would support a serial or parallel device. An unterminal is a monochrome EGA or VGA monitor with a hard-switch AT/XT keyboard.

By adding a 386 or 386SX system with a math coprocessor, Post's office could produce electronic-publishing output and perform graphical analyses of its client's portfolios.

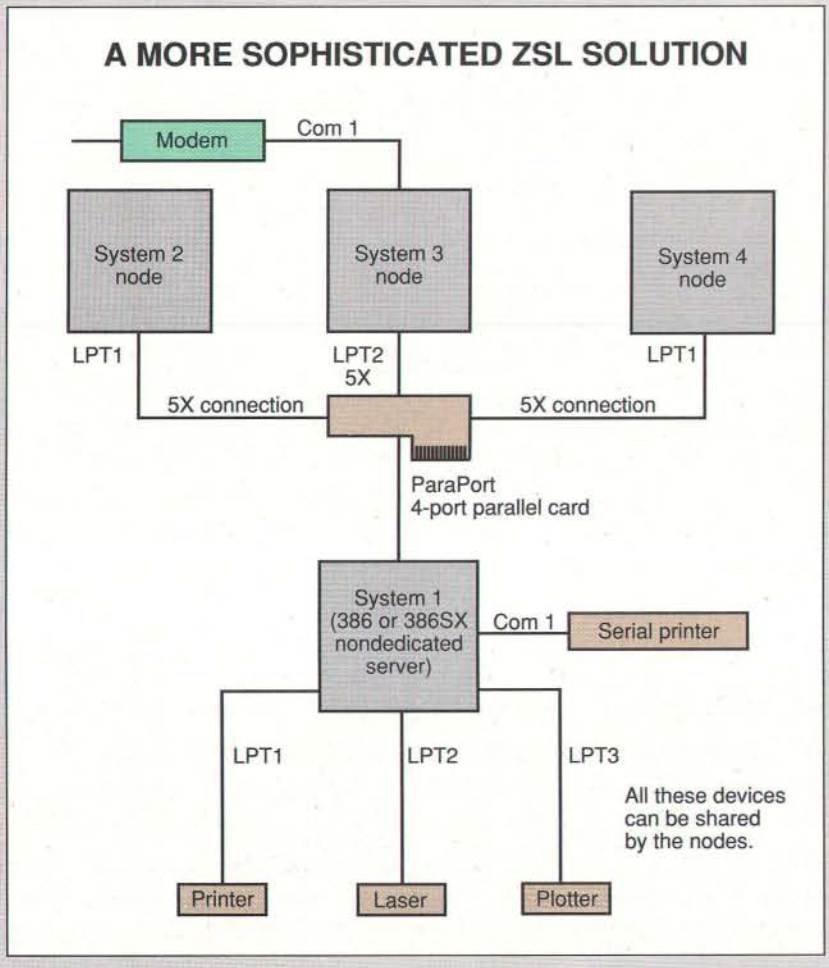

Figure B: *In this LANLink 5X/PC-MOS hybrid network, System 1 is running single-user PC-MOS. To give the nodes access to the server, Post installed a ParaPort card (four parallel ports) in the server. This system provides full file transfer, file-sharing, and program-execution capabilities.*

rate is too slow.

One of the most important ZSL improvements has come from the expanded ability of some peer-to-peer products to plug into your machine's parallel port and run at 500,000 bps. LANLink 5X, for instance, can use either serial or parallel ports to connect PCs and peripherals. Up to 16 nodes can be networked to one server PC, which can be either dedicated or nondedicated. Using this system, you can choose either serial or parallel connections for your PCs and peripherals.

You can connect up to 16 PCs, PS/2s, and laptops by using a plug-in parallel port device with 3X-Link16. This TSR can securely transfer files in the background at 500,000 bps and provide you with an internal E-mail capability. It can also connect your devices to other workstations or servers on another network and, with an optional program, perform printer sharing and spooling.

ZSLs such as 3X can now fill your heavy-duty computing needs as well, including the ability to access plotters and use optical drives to store large graphics files. A NetBIOS-compatible version of 3X supports multiuser software packages, provides file and record locking, and allows you to connect single-floppy disk drive workstations.

There are as many ZSL enhancers available today as your finances will bear. Among them are system utilities, gateways, cards, and adapters that a ZSL can use to perform more like a full-featured LAN.

For instance, there are Ethernet cards that offer diskless remote booting and selectable I/O base addresses as well as diagnostic LED displays that let a peer-to-peer network monitor real-time cabling signals. With these cards, you can also increase the number of nodes your system can handle and the distances between nodes. Other ZSL options include a variety of protocol converters and Ethernet or Token Ring ports, along with serial and parallel interfaces that let you use peer-to-peer networks as communications servers.

You can also obtain some high-level operating systems for low-level ZSLs that gentrify a network and enable you to run a ZSL in a small amount of base memory. LANtastic's NOS (for network operating system) allows you to use passwords and audit trails for security purposes. Using PC-MOS from The Software Link, you can turn a peer-to-peer network into a multiuser, multitasking hybrid network.

The term "sub-LAN" was coined and trademarked by Pete Peterson to refer to a more full-featured ZSL. It means an asynchronous, peripheral-sharing box with smarter firmware and software. You can now take advantage of sub-LANs, which inexpensively provide fault tolerance by backing up all the PCs' hard disks on the network. In addition, they provide loosely coupled gateways to a mainframe, as well as more architectural flexibility. NetCommander can already support 3278 emulation and will soon be capable of using fax servers.

In tandem with some of the higher-level peer-to-peer networks, you can now use ISDN to plug into the benefits of using both voice and data at the same time. With LANLink 5X and PC-MOS or an emulation product used with an ISDN terminal adapter, for example, you can now take advantage of available ISDN services on either a DOS terminal or a MOS host.

Under certain circumstances, with this combination of a ZSL, a special operating system, and the enabling ISDN technology, you can perform file transfers

continued

COSTS: SUB-LANS VS. LANS

Table 2: A comparison of the estimated 5-year operating costs of a typical sub-LAN and a full-featured LAN. In this example, the sub-LAN would cost only about one-sixth as much as a LAN. The figures are per port and do not include automatic backup. (Information is courtesy of Digital Products, Inc.)

Expense	Sub-LAN	LAN
Hardware and software	$350	$1400
5-year network support	500	5000
5-year maintenance	175	700
Total	**$1025**	**$7100**

without sacrificing voice capabilities. In addition, without the use of cabling, you can rapidly bring up a database over an ISDN switch, share screens with other users, share peripherals over long distances (either local or wide area), and even carry on a teleconference.

Yes, No, and Maybe

With increased speeds gained from plugging peer-to-peer networks into a computer's parallel ports, ZSLs became more viable alternatives to hardware-based LANs. But because serial-based ZSLs are easier to install and use, parallel-based peer-to-peer networks have not caught on in as rapid or as serious a fashion as industry leaders thought they might.

Some users are now going to another relatively new networking scheme called the wireless LAN (see "On the Radio" on page 224A). Because this alternative cutting-edge technology is gaining in popularity, ZSL developers may decide to create more sophisticated peer-to-peer networks. They may come out with ZSLs that can combine the use of either the parallel or the serial port and an inexpensive hardware card to provide benefits similar to those currently derived from high-end LANs.

Is there currently a place for ZSLs? Well, yes, no, and maybe. The best answer is yes, because of the new enhancements to this type of peer-to-peer LAN. Most people agree that, for some applications and for some types of installations, there is a niche for ZSLs, and there probably will be for some time to come.

It is possible—even likely—that ZSLs will evolve into a more hardware-like product. This type of hybrid network would provide advanced features and benefits—priced higher than today's, yet lower than full-featured LANs—and require far less support. If that scenario evolves, would this type of peer-to-peer network still qualify as a true ZSL? Probably not. ■

Janet J. Barron is a BYTE technical editor. She can be contacted on BIX as "neural."

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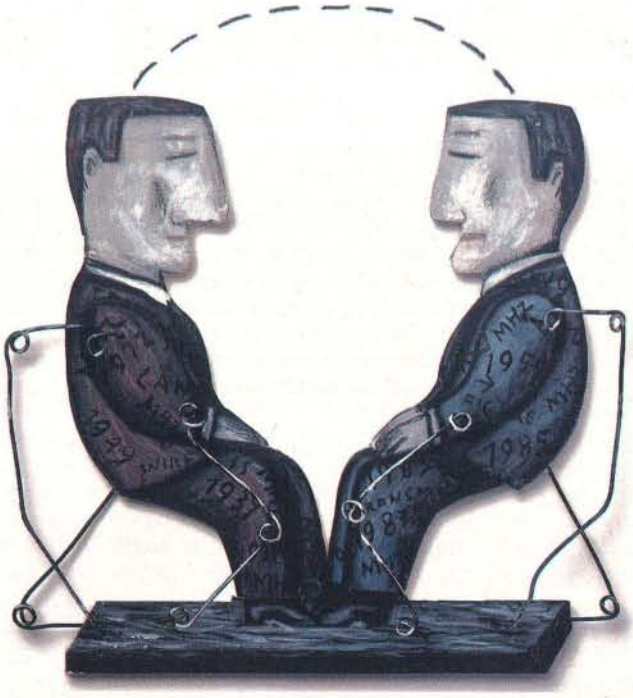
On the Radio

Wireless LANs give new meaning to the term "ether" net

Sorin Davidovici

For all its high-tech glitter, the most important parts of a LAN are the wires that tie it together. Choosing the right cabling is fraught with uncertainty, and installing it can be very expensive and disruptive to an operation. Eliminating the need for expensive cabling is the main attraction of wireless LANs.

Wireless LANs provide a flexible alternative to traditional, cable-bound networks. They let you move network nodes, instead of having to hard-wire your configuration when you install the cabling. They also provide networking where cable installation is too expensive or impractical. Finally, they provide portable nodes for your network, letting you bring the power of the network to bear where it is needed.



While wireless LANs share many features with standard networks, they take many different approaches to the questions of node addressing and network security. The differences reflect the wireless nature of their communications.

Keeping in Step

As on standard LANs, all computers on a wireless network must follow the same protocol for sending and receiving data. Over the years, various manufacturers have developed and used several protocols. Although computers with different protocols normally can't communicate, all protocols implement similar functions to achieve the ultimate goal: accurate transfer of data between computers.

Major computer manufacturers often have their own proprietary data transfer protocols. While they work well, they do not allow you to easily mix and match computers from different manufacturers. To remedy this, a set of "open" protocols is emerging that, by being in the public domain, will be available to all manufacturers and will enable all computers to communicate. The International Standards Organization has developed a model for these protocols.

Model Building

The Open Systems Interconnection (OSI) Model describes a computer communications protocol in terms of seven layers that provide the major communications functions (see figure 1). Each of the layers takes data from the lower layer, adds value to it, and then passes it to the next higher layer. Wireless LANs are concerned only with the layers that govern channel access and raw data transfer.

The Physical layer of the OSI model addresses the physical transmission of raw data over the communications link. The protocol associated with the Physical layer specifies signal voltages, signaling rates, and other physical quantities to

continued

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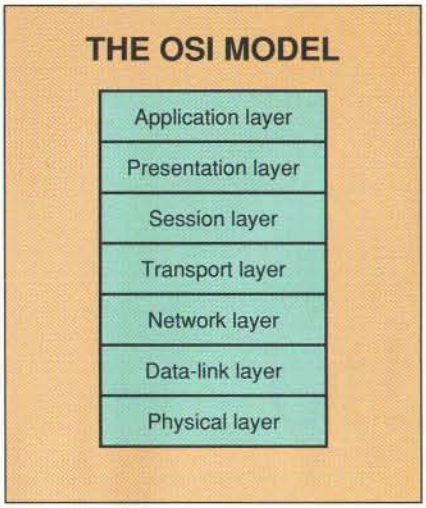

Figure 1: *The OSI Model consists of seven protocol layers that allow dissimilar computers and applications to communicate and share data. Wireless LANs concern themselves with the Physical and Data-link layers of the model, which describe the physical nature of the connection between two machines and an error-free method of data transmission over that connection.*

ensure that, if you send a 1, all computers connected to the network receive a 1 and not a 0. The Physical layer is the domain of electrical engineers.

The Data-link layer takes a physical connection capable of transmitting raw data and transforms it into a link capable of error-free data transfer. At the sender, this layer breaks messages up into data frames (typically a few hundred bytes each). At the receiver, it processes the incoming frames, acknowledges the frames received correctly, and causes those received in error to be re-sent. The Data-link layer attaches special bits to the raw data that mark the beginning and end of each frame and enable the receiver to recognize the presence of any channel-induced errors in the received frame.

Gaining Access

Point-to-point communications—such as those between a terminal and a computer—are easily handled by the protocols associated with the Physical and Data-link layers. Communications that involve more than two entities sharing the channel, however, are more complex.

For example, consider an office network where several computers share a channel (called a broadcast channel) that they all can access simultaneously. To understand the difficulties associated with broadcast channels, think of a simple telephone conversation as opposed to a conference call. In a two-party telephone conversation, it is usually easy to determine when you should speak and when you shouldn't and, thus, to have an orderly exchange. Contrast this to a conference call where, when one person finishes speaking, several people break in at the same time. In this case, access to the medium requires a more sophisticated protocol. In data communications, the IEEE's 802.x family of protocols is designed to do just that. The most popular is Ethernet, described in the IEEE 802.3 protocol.

The unique features of wireless networks are concerned with the channel-access and data transfer functions of the OSI model. Basic to wireless communications is the Physical-layer implementation, which allows wireless transfer of data over a broadcast channel. Two major new technologies exist that perform this function: spread-spectrum and photonic communications.

Across the Spectrum

In 1985, the Federal Communications Commission (FCC), which governs the allocation of spectrum (i.e., frequency bands) in the U.S., allocated several frequency bands to communications systems that use a new form of modulation called *spread-spectrum* (SS) modulation. Its assigned frequency bands are 902 MHz to 932 MHz, 2400 MHz to 2483 MHz, and 5725 MHz to 5850 MHz.

Although SS modulation is new to commercial communications systems, it has been used in military communications systems for several decades. Simple forms of SS modulation are very similar to the AM and FM systems used in commercial broadcasts.

Piggyback Data

All wireless communications systems, whether they transmit analog or digital data, superimpose the data on an auxiliary signal called a carrier. This carrier enables the receiver to separate the desired signal from many active signals and limits mutual interference. The amplitude, phase, or frequency of a carrier signal is modulated (modified) according to the information to be sent. The receiver detects these changes and recovers the original information. If the carrier signals are appropriately spaced in frequency, the modulated AM or FM signals will not overlap. Thus, even though the input signals share the same frequency band, the modulated signals are separated in frequency. The frequency separation makes it possible to extract the signal of interest from a multitude of signals active at the same time.

A carrier signal is simply a sine-wave signal. Receivers select specific signals by using a filter tuned to the appropriate frequency. All other signals, which are simply interference, are eliminated. Once the signal is snatched out of the ether, the receiver extracts the information contained in it in a process called *demodulation*. If the signal in question originates at a commercial FM station, it most likely carries music and speech that are amplified and played through the speakers after being demodulated. In data communications, the data is extracted by the Physical layer and passed on to the Data-link layer.

Spectral Gains

In addition to extensive use in commercial radio broadcasts, AM and FM have found applications in data transmission modems. Figure 2 illustrates AM and FM signals modulated by a 11010 data pattern. Note that both systems transform data represented by 0s and 1s into 1s and −1s, which are better suited for transmission.

Simple SS modulation is a slightly more complex form of AM and FM. In addition to the carrier, it uses a second auxiliary signal in the modulation process. This signal is a user- or network-specific digital code with a much higher transfer rate than the data (i.e., the duration of an auxiliary-code bit is much shorter than the duration of a data bit).

SS modulation techniques are characterized by the use of a spreading code as an auxiliary signal. The most popular techniques are direct-sequence (DS) and frequency-hopping (FH) spread spectrum. Simple forms of DS-SS modulation are very similar to AM, while simple forms of FH-SS resemble FM.

Both DS-SS and FH-SS systems multiply the data and the auxiliary code together and then modulate the carrier by the resulting signal. An important attribute of SS systems is the *processing gain*. The processing gain is simply the number of spreading-code bits (commonly called *chips*) that fit in a data bit. Figure 3a shows an SS system with a processing gain of 4. It takes the data pattern 11010 and multiplies it by a spreading code (in this case, 1011 0010 1011 1001 0100) that contains four times as many bits as the data signal, resulting in a signal with a higher rate than the incoming data.

Because the spectral requirements of a digital signal (i.e., the required bandwidth) and the signal rate are directly

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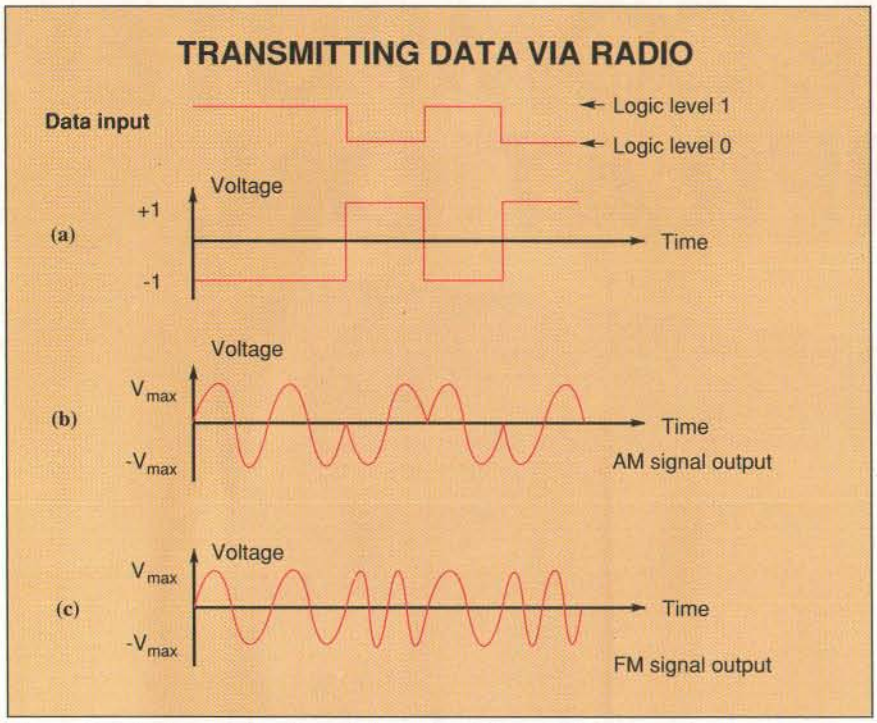

Figure 2: (a) *Transmitting digital data using AM and FM communications requires that you first transform binary 0s and 1s into a form that analog systems can use more easily.* **(b)** *For AM transmission, you represent the data by modifying the voltage of the carrier signal.* **(c)** *In FM transmissions, you represent data through changes in frequency.*

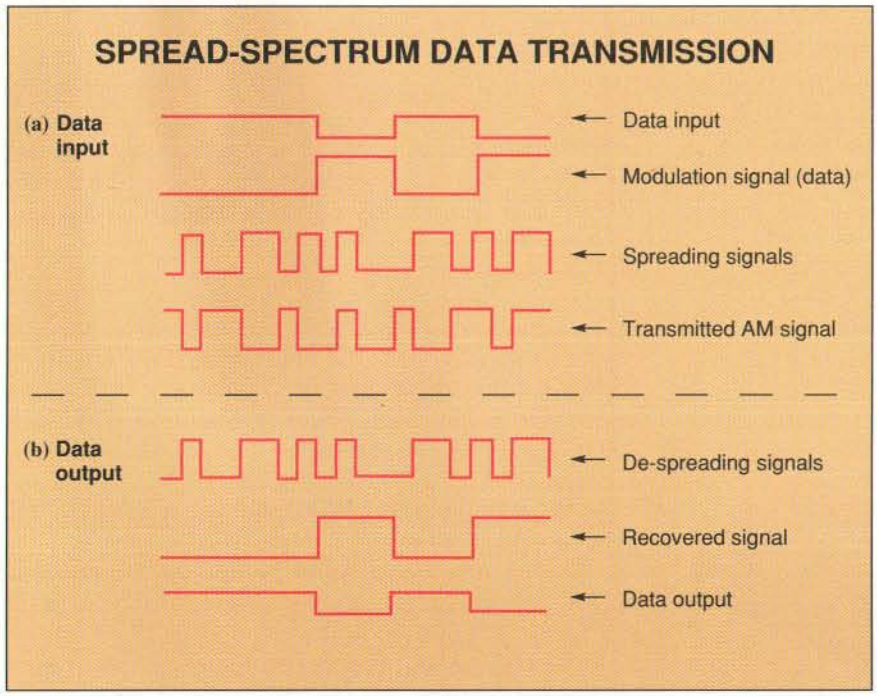

Figure 3: (a) *To encode data in a direct-sequence spread-spectrum system, you convert the input data to a usable form, multiply this by the spreading code, and send the results to the AM transmitter.* **(b)** *To decode the signal, you multiply it by the spreading code and convert the results into binary 0s and 1s.*

proportional, the modulated signal requires four times the bandwidth of the original data. The term "spread-spectrum" is derived from the increase in signal bandwidth indicative of the processing gain. Practical systems use a processing gain of 10 to 1000 or higher, depending on the application.

Figure 3b shows how a system demodulates the combined data and spreading signal. The receiver knows the spreading code and multiplies it by the input signal to recover the original data.

Keep Out

To recover transmitted data, you have to know the spreading code that is used at the transmitter. The code also prevents others from eavesdropping on your communications. Although a processing gain of 4 is useful in illustrating an example, it is not very useful for ensuring data privacy. A would-be eavesdropper could simply use all possible combinations of 4 chips per bit (i.e., 16 combinations) and decode the original data. However, even a modest increase in processing gain to 16 increases the number of possible spreading patterns per bit to over 64,000; the eavesdropper would have a much more difficult task in decoding the data. A processing gain of 1000 makes eavesdropping virtually impossible.

The same mechanism that makes unauthorized reception of a DS-SS signal so difficult makes the simultaneous operation of SS systems possible. In AM or FM systems, you differentiate signals based on their carrier frequency. In SS systems, you differentiate among signals by their spreading code; the carrier frequency of all signals is the same. Different spreading codes let many computers share a common channel. This channel-access method is called code-division multiple access. With CDMA, all users have the same carrier frequency. What separates the many simultaneous signals at the receiver is the specific spreading code assigned to each one.

Consider, for example, the situation depicted in figure 4. Multiple signals are present simultaneously at the receiver, and all signals share the same carrier frequency. But unique to each signal is its spreading code. The receiver has the same spreading code as the signal intended for it. By multiplying the intended signal by the replica of the spreading code stored at the receiver, you produce a steady high level from the decorrelator. The other signals present at the receiver's input have a different spreading code. Their output appears as

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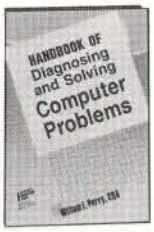

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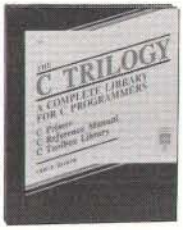

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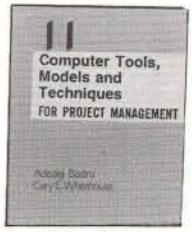

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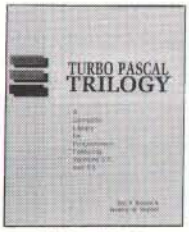

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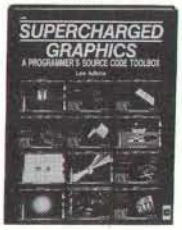

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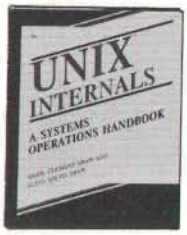

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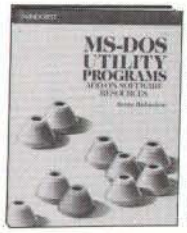

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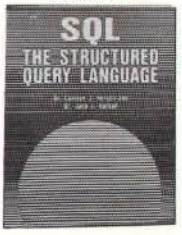

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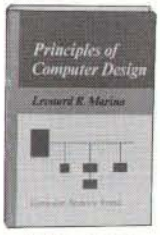

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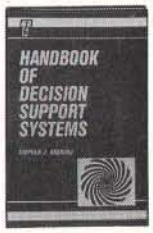

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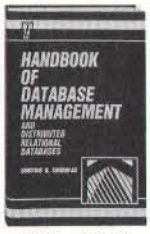

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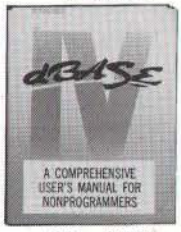

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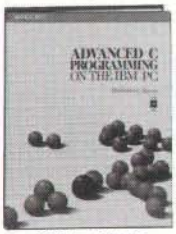

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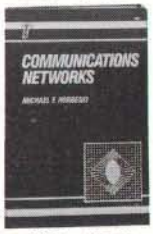

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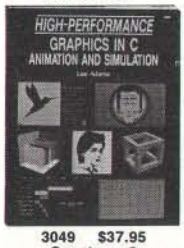

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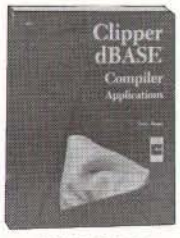

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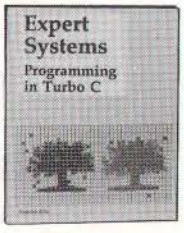

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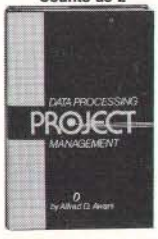

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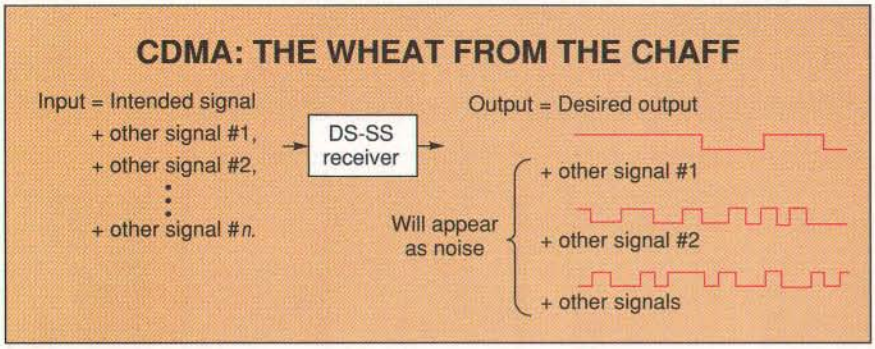

Figure 4: *The code-division multiple-access method of data recovery separates overlapping signals on the same carrier frequency. Spread-spectrum systems use the spreading code for this purpose. This ensures that only one signal produces valid data. Other signals produce noise when decoded at the receiver.*

noise. Provided that not too many of these signals are present, the receiver will be able to correctly recover its intended data.

FH-SS systems are very similar to FM systems. In FH-SS systems, the spreading code is used to change the nominal frequency of the carrier from time to time. The "hopping rate" refers to the number of times per second the carrier frequency changes.

In an FH-SS system, the data changes the frequency of the carrier by a fixed amount above or below its nominal frequency depending on its polarity. Many FH-SS systems can coexist because the nominal carrier frequencies are continually changing. For as long as any two or more signals do not take the same nominal carrier frequency at the same time, they will not interfere with each other. If the system is properly designed, this kind of interference will occur very infrequently. As the number of active systems increases beyond a threshold, the mutual interference becomes more frequent, and eventually the system becomes unusable.

Networking with Light

You can transmit information using even higher frequencies than those used by the SS systems. One example of this is an infrared TV remote controller. The same principle can be used to send information from any transmitter to any receiver, not just from a remote control unit to a TV. Systems that send and receive information using light are called *photonic*.

Just as a cable connects all the computers in a conventional LAN, a photonic system must provide unobstructed access to a common reflecting surface (such as a ceiling). This surface provides a broadcast medium that all transmitters and receivers can access simultaneously. Interference in such a system comes from other photonic sources, such as sunlight.

Thus, as with SS systems, the Data-link layer of a photonic system must ensure that the data is received correctly. Because the interference encountered by photonic systems is different from interference in SS systems, the error-detection and -correction mechanisms are also different.

Differences in the technologies employed in SS and photonic devices carry over into their areas of application. SS technology is simple radio communications. It has the ability to penetrate obstacles, such as walls and closed doors, and it links computers even if they are located in different (but not too distant) rooms. Photonic devices need a line of sight; they operate best in large, wide-open areas where they have an unobstructed line of sight to a common reflective surface.

LAN Choices

In an office environment, the important question is not whether you need a network, but what kind of network services you need. The simplest network function is sharing expensive peripherals. You don't need a full-fledged network for this. Cheaper alternatives, such as peripheral-sharing devices capable of connecting from two to eight users, are all you require. The cost associated with these devices generally varies between $50 and $100 per node, and they are capable of transferring data at speeds as high as 9600 bps. Whether the peripheral-sharing devices are the manually operated variety or the more expensive automatic ones, they still need to have wires attached to the computers and the peripheral devices.

Take a basic peripheral-sharing device and add more electronics and some memory-resident communications programs, and you enter the domain of data switches. These offer all the advantages of the peripheral sharers plus the ability to exchange data. You can use them to implement E-mail and file exchange. The maximum number of ports available increases to as many as 48 or even 64, and the data transmission speed is usually 19,200 bps or higher. At $100 to $250 per node, data switches are more expensive than simple peripheral sharers, but they still require that you cable all the devices together.

If, on top of all the above services, you need to share applications software, your only solution is to install a true LAN.

Where do wireless LANs fit in this scheme of things? Most wireless LANs consist of devices that implement the Physical and Data-link layers and use a memory-resident program to provide access to the functions of the wireless device. The memory-resident program serves as a substitute for (and implements a subset of) the functions normally implemented in the upper layers of the OSI model.

In the Field

You can buy wireless networking products from a number of companies. The cost and sophistication of these products vary widely. Undoubtedly, two of the most sophisticated (and expensive) systems are the Agilis system and the AR-LAN system.

The Agilis system, available from Agilis Corp. (Mountain View, CA), consists of a small, portable computer you can configure using different modules. The wireless communications module uses an SS technique and operates in the 902-MHz to 928-MHz band. The Agilis system's link sustains a data transfer rate of 230,400 bps. The price of the system varies from $2000 to $20,000, depending on the configuration. Note, however, that the wireless data communications system can currently be used only with the Agilis computer; it cannot be removed and used with other computer systems.

The ARLAN system from Telesystems SLW (Don Mills, Ontario, Canada) does not include a computer. It is solely a communications system designed to be used with *your* computer. It consists of a network controller unit that communicates with several network units and is priced at about $1200 per node.

At the other end of the spectrum, you find LAWN (for local-area wireless network), which, at $500 per node, is one of the least expensive ways to implement an

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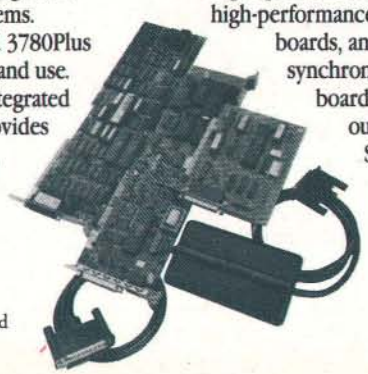

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SS network. Manufactured by O'Neill Communications (Princeton, NJ), it is about the size of a modem and connects to the serial port of the PC. LAWN comes with a floppy disk containing the memory-resident access program.

LAWN consists of an SS radio operating in the 902-MHz to 932-MHz band, and a microprocessor and a proprietary application-specific IC that implement all the functions of the wireless network without making any processing demands on the host PC. The effective data transfer rate is 19,200 bps. LAWN operates in one of four channels, A through D. If one network gets too crowded (i.e., has more than about 20 users), you can put up to three more networks on the remaining channels. All four networks can then simultaneously operate at 19,200 bps.

LAWN ensures data security by letting you choose one code from a possible 65,536. You can change this code as often as you like. You identify the network nodes by name. The hardware stores your settings in battery-backed memory. Therefore, recovery from a power outage is automatic; you don't have to reprogram the network.

LAWN Operations

Setting up and using the network is simply a matter of activating the memory-resident program. You enter commands (except for setting operational parameters such as channel number, security code, and node name) using menus. You can send mail, transfer files, and route printer jobs to the shared printer.

LAWN uses AX.25 as its link-access protocol. AX.25 is a version of the X.25 packet data communications protocol modified for amateur radio operation. It uses some interesting features that solve problems specific to data transmission in wireless (radio) environments. It allows you to relay transmissions through several nodes, which extends the range of the system. Without using the relay function, the transmission range is about 100 to 200 feet in an indoor environment.

In normal operation, LAWN automatically establishes a link, transfers the user data, and then relinquishes the link. Transfer operations take place in the background and are invisible to the user. However, LAWN does have the ability to manually establish and maintain a link. This is useful when you access a modem via the network. You should take care to relinquish the link at the end of the session. Otherwise, the device will be inaccessible to others.

Growing Up

Advanced wireless technology has come of age. The first generation of wireless networks is already at work in small offices. The results are encouraging; the low traffic volume in a small office lets you add printer sharing and E-mail without the inconvenience of cabling.

In the future, larger wireless, multiple-office networks will need increased range, requiring either a major transmitter power-level increase (unlikely to be permitted by the FCC) or a more sophisticated system design. Thus, you can expect future systems to be grouped into two categories: expensive, fast, wide-area systems; and low-cost, slower, medium-coverage-area systems. In either case, you get the benefits of a flexible, wireless system. ■

Sorin Davidovici holds a Ph.D. in electrical engineering and is currently working with the U.S. Army. He can be reached on BIX c/o "editors."

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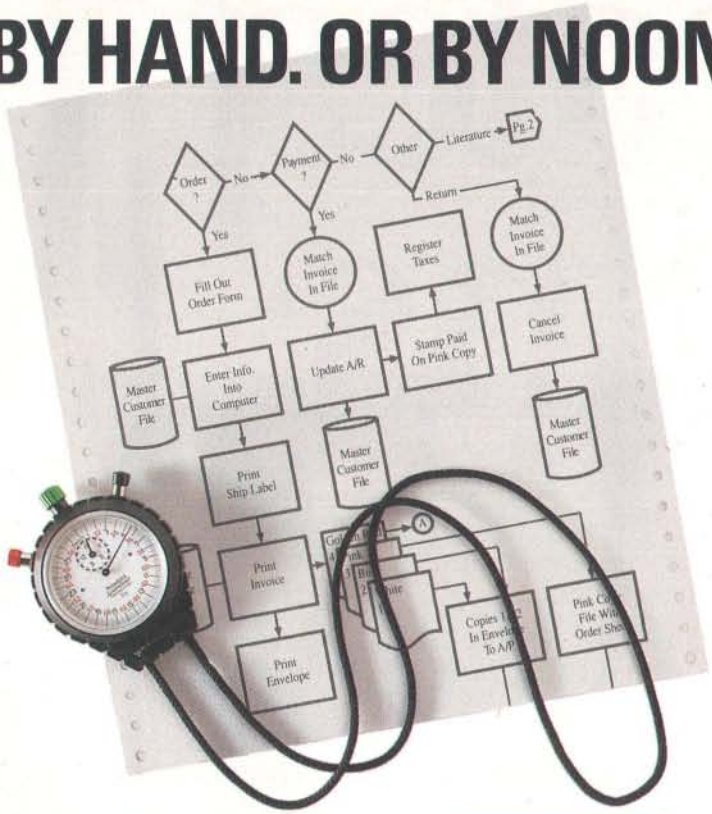

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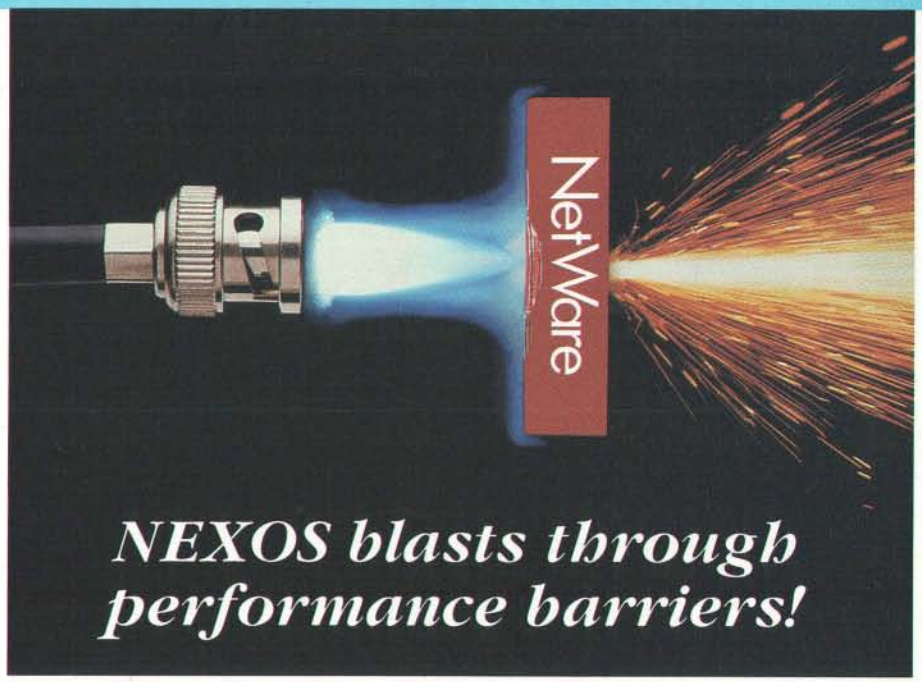

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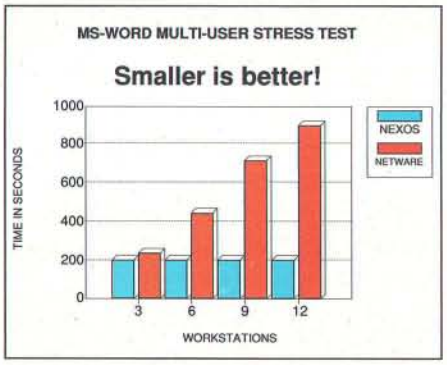

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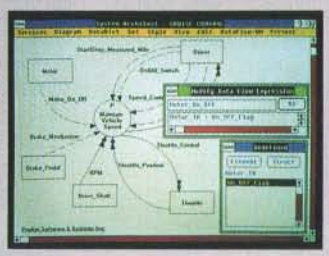

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Need More Fiber?

It can transmit more data than copper, and it's more secure

Sharon Fisher

When a company talks about getting more fiber, it's not talking about oat bran. It's referring to a communications medium—fiber optics—that provides higher speed, more capacity, and better security, for not too much more than today's copper cables.

At present, you find fiber in the cabling that some communications companies have strung across the U.S. and under the oceans, and in a few data communications products. In the future, though, you may see a single fiber strung to your home or office that carries voice, data, and video—including cable TV and teleconferencing.

Why Fiber?

Companies are beginning to move to fiber for several reasons. First, it can transmit more data faster than the alternatives. For example, the Fiber Distributed Data Interface (FDDI) supports data transmission speeds of up to 100 megabits per second. In comparison, Ethernet transmits data at 10 Mbps, while Token Ring transmits data at 4 or 16 Mbps.

In addition, a fiber-optic network tends to be more secure than a copper cable network. It's not perfect, but it's better. Copper networks have some problems: They can be tapped, and they tend to emanate electrical signals that people can pick up and interpret. You can't easily tap a fiber cable (and doing so may bring down the network) or monitor emitted signals.

These properties give fiber other advantages, too. Because electrical signals don't escape, a fiber network can't interfere with any sensitive electrical equipment that might be nearby. And a fiber cable between two buildings won't attract lightning, as a copper cable might.

But these factors also make fiber networks more expensive to set up. For example, according to Nate Walker, product marketing manager for fiber optics at Hewlett-Packard's optical communications division, connecting a PC to a standard cable network might cost $1000 to $1500 per node, counting the cost of the adapter, attachment, and the network itself. In comparison, connecting an FDDI node costs in the range of $6000 to $10,000. Even the components themselves are more expensive: Where Ethernet components might cost $35 to $40 or less, FDDI components may cost $500 to $600.

Optical cable is also more expensive than standard cable. Some vendors are looking into making fiber-optic cable out of plastic rather than glass, which could bring the cost per foot down to not much more than unshielded twisted-pair cabling. But plastic's characteristics are different from those of glass. According

continued

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On the Threshold of a Dream

Richard Jay Solomon

Despite predictions—and massive investments by a host of companies—videotext information services have never caught on with the public at large. The problem may be that an online information service is an idea ahead of its time, or at least ahead of the technology needed to deliver it.

Hypermedia—which combines online interaction and database technology with advanced video, audio, and display technologies—is a natural extension of ASCII-based videotext services. However, hypermedia requires very high-speed communications connections to make it successful. The backbone of such connections will be the fiber-optic broadband networks coming your way in the 1990s.

Service Integration

Unlike videotext, which provides relatively slow speed data (normally via modem on a voice line), hypermedia needs something that's faster to integrate voice, video, and complex data streams. The first step on the road to such integrated services is ISDN, which is fast enough for only rudimentary hypermedia services.

The ISDN standard is narrowband; its basic rate consists of two 64,000-bps "B" channels that run simultaneously with a 16,000-bps "D" signaling channel into subscriber premises. It is available over specially balanced conventional wire pairs. A primary rate of 1.5 megabits per second (2 Mbps in Europe) is specialized for special circuits. Furthermore, ISDN is defined with channels of fixed bandwidth.

While that sounds fast if you use a 2400-bps modem, it's not fast enough to carry and switch certain services, such as high-definition video. Nor is it fast enough to implement certain types of user-shared network control, to interface directly with LANs, or to permit direct memory access to CPUs.

ISDN may be sufficient for residential users who do not require full-motion video or high-resolution graphics, but it simply will not fit the needs of business, education, or industrial processes in the near future. The popularity of ever-faster LANs attests to this. But even for residential voice, ISDN's 2B + D makes little sense. The B channel is overkill for a voice circuit; you can buy modems that operate within the range of the D channel for such things as standard videotext. Getting a second analog loop for another voice circuit is not a major problem in the U.S.

ISDN is best characterized as a carrier-driven intelligent network that emulates today's voice and slow-speed data systems. You would be extremely hard-pressed to implement a full-fledged hypermedia network using ISDN.

The Broad Spectrum

Beyond ISDN, the communications industry has proposed a broadband ISDN standard for fiber-optic transmission. B-ISDN isn't simply a bandwidth extension of ISDN; it turns the original ISDN concept upside down. Instead of an intelligent network, the carrier becomes somewhat passive—but with all-important options for variable bandwidths and minimum delay times.

Control of routing and other operations can be shared by the carrier and the user and driven by the user's computers. This is a big difference from today's networks because it permits true virtual networking. B-ISDN may make it impossible to differentiate between the carrier and the customer. In the U.S., there have been proposals for nationwide gigabit-per-second systems (like the earlier ARPANET) to connect universities and research centers.

The promise of B-ISDN technology is so powerful and overwhelming that ISDN may be obsolete before it comes into general use. Optical transmission will permit new forms of broadband switching, as will superconductors and optical processors. For the first time in the history of communications networks, there will be bandwidth to play with. Excess bandwidth permits a large fraction of the digital transmission rate to be used for "overhead" bits to route and keep track of the "payload" bits.

The ratio of overhead to payload is critical. Primary-rate ISDN uses about 5 percent of throughput for overhead data. At the 150-Mbps rate currently proposed for initial B-ISDN deployment, about 10 percent of the channel throughput can be allocated for overhead and still yield a payload of about 135 Mbps. Although B-ISDN overhead is 10 times the size of the entire capacity of primary-rate ISDN, its payload is about 90 times as large.

With 15 Mbps for control and administrative data, you can build different—and potentially superior—flexible network architectures. Such order-of-magnitude changes in the ratios of overhead to payload permit complex routing and switching to be manifest on the circuit, instead of only at a node. Junctions can be simpler, networks can be extremely robust, and users can control routing and the level of service.

Packaging Information

Asynchronous transfer mode (ATM) is the generic name for a subset of the B-ISDN proposal. It is neither a new form of packet switch nor a mere extension of switching as most people understand it. Rather, ATM packets have the data framed in the form of a matrix envelope. The matrix is constructed as if it were a relational database, with pointers or labels.

This pointer technique is extremely powerful, permitting routing and data massaging as part of the transmission procedure itself. Pointers and envelopes can be contained within other envelopes with additional pointers, expediting the ready, dynamic construction of virtual networks that will be invisible to the carrier. ATM's overhead contains its own signaling as part of its interface framing.

ATM provides a framework that lets you encapsulate many kinds of data. However, coming up with an optimal network architecture, nodal design, and switching system for general use will require a lot of experimentation. There are many questions to be answered as to how B-ISDN will (or can) handle video services, voice, and data—all mixed together. Except for the local loop, such integration may be impractical.

The exact design of standards for future TV and database access may eventually rule the way broadband networks are implemented and operated, rather than the other way around. Experiments performed over the next few years will point the way. The IEEE and U.S. B-ISDN (ANSI T1.D1) committees have agreed on common interfaces to permit linking fiber LANs and metropolitan area networks, or MANs, with B-ISDN systems at speeds of 100 Mbps and higher.

How switching and customer equipment will handle ATM frames isn't settled yet. Standards for the services made available over B-ISDN, especially for remote database massaging and high-definition TV (HDTV), will likely

have to closely match ATM designs. Coordination of such standards has only just begun, and some rethinking of both switched optical fiber and HDTV standards models will be required to make them commercially viable. Fortunately, neither standard has yet been poured in concrete, in terms of investment by carriers and users.

A group of technical experts from the TV, film, computer graphics, telephone, and signal-processing fields has formed the Committee on Open High-Resolution Systems. Its purpose is to design a family of "friendly architectures" that would aid the standards bodies in harmonizing work between HDTV, existing transmission and storage modes, and future all-digital broadband transmission systems.

In addition to technical and standards questions, broadband systems engender many institutional problems as well. These range from the ease with which information can be transmitted and duplicated (and hence ripped off) to the difficulties of setting tariffs. For example, do you charge by the bit or by connection time, and what do you do in situations where time can be compressed in arbitrary ways for different services? Most difficult of all, how do you charge equitable rates on a B-ISDN system in which a basic telephone call can use 64,000, or even 16,000 bps (at 5 cents per minute) and a 1-hour HDTV program runs at 100 Mbps? Charging fees of $18,750 per hour won't fly in the TV business.

Broadband Time Line

In one sense, broadband is here today; most U.S. cities are connected by a multitude of fiber-optic trunks, which reach virtually every urban and suburban telephone switching center. New applications, however, depend on going the "last mile"—bringing broadband into homes and businesses.

Because residential use for broadband would center around TV, it comes into competition with cable, direct-broadcast satellites, VCRs and videodisks, and plain old broadcasting. Interactive broadband will come to the home when the cost of fiber local loops (and the optoelectronics needed to support them) make broadband an affordable alternative to copper, and when the political problems are resolved.

Shifting Sands

Widespread availability of broadband, in combination with powerful desktop computers, will bring about nothing less than a *paradigm shift*—a completely new model—of how you view and use computer-based communications.

While used extensively in switching, the true power of digital computers has rarely been applied to networking, for reasons ranging from politics to ignorance. While computers that switch circuits permit some interesting new services—caller identification or user-to-user signaling, for instance—computers that are linked to fiber-optic-based digital broadband networks will radically alter how you perceive and use networks in the near future.

Why? Although digital computers communicate in a broadband fashion internally, communications between machines have, until now, been many orders of magnitude slower than their internal communications. The computing side has been limited by the communications "choke point." In the future, linking machines at speeds equal to or exceeding their internal bus speeds will let you create radically different network architectures.

The HDTV Picture

The advent of broadband networks and applications such as hypermedia is forcing a merger between communications and data processing. One of the most important aspects of this merger is the concept of an "open architecture" terminal that could act as a generalized interface between users and very high-speed fiber-optic networks, satellite networks, and over-the-air transmission. Such a terminal would be equally suitable as either a computer display or a video display. Specialized subsets would include low-cost TV-only displays, dedicated interactive terminals such as automated tellers, and high-resolution bulletin boards for airports and the like.

This doesn't mean that microcomputer manufacturers would necessarily enter the TV business—or vice versa. It does mean that future TVs and computer monitors will be able to display the same types of moving images. Today, conversion between standard TV images and computer displays is difficult and unsatisfactory.

Any high-resolution display, for TV or otherwise, uses significant computational power, memory, and storage to minimize the bandwidth needed for data transfer over noisy transmission lines. With such built-in digital power, advanced applications for high-resolution displays become feasible.

From the perspective of the computer industry, high-resolution systems that recognize growth and innovation in displaying moving images will benefit by using open architecture based on line-independent representations. Some have called this "PostScript Video," implying a high-resolution standard that includes extensibility, independence from line and pixel parameters, a bus designed to mesh its backplane directly with evolving standards for digital fiber, and the use of modern bandwidth-conservation optimizations.

If, due to consumer demand, open architecture terminals become commodities in the next decade, businesses will benefit from the immense economies of scale that consumer electronics brings to bear on the manufacturing and distribution of such displays. Conversely, if business, industry, and the military adopt high-resolution displays first, it could make compatible terminals attractive to the consumer market, where continued bickering about standards for HDTV threatens its timely and widespread acceptance.

Since the existing movie and video plant of 24-Hz, 25-Hz, and 30-Hz (actually 29.97-Hz) systems represents an enormous worldwide investment in programming and equipment, it is unlikely that a complete replacement with new systems will happen quickly. Only the high-resolution designs that are downwardly compatible with these three basic frame rates will stand any chance of success.

Upward compatibility for the future is equally important. The current—and sometimes bizarre—debate over line and frame rates for future TV systems could be laid to rest by adopting a model based on an open architecture. In this case, the interfaces between modules are the only things that need to be standardized.

Harmonic Convergence

The use of hypermedia won't become widespread before the turn of the century. It involves the implementation of a fiber-optic communications network, the promulgation of new communications standards, and the adoption of a digital-based open architecture display technology, as well as advances in AI, database technology, and expert systems used to implement the hypermedia databases.

The road is long, and there are many obstacles to overcome. But the benefits of hypermedia will make it all worthwhile.

Richard Jay Solomon is a research affiliate at MIT's Research Lab on Electronics and is a research associate of the Communications Policy Program at the MIT Media Lab. You can reach him on BIX c/o "editors."

to Walker, plastic is easier to connect to, but it has different wavelengths and different bandwidth (see the text box "The Future Is Plastics" on page 256 in the January 1989 BYTE).

The Big Bucks

The major expense with any kind of cabling, however, is installation, mainly due to labor costs. Installation may involve opening up a wall and running the cable to each desk. When companies first installed telephone cabling, they often ran three or four times as much as they needed—unused twisted-pair cabling that can now be used inexpensively for networks. This isn't the case for fiber.

For this reason, according to Walker, a number of companies that are stringing standard cable for other uses—constructing or renovating a building, or adding more capacity, perhaps—are also stringing fiber-optic cable at the same time, even if they don't plan to use it anytime soon. Some companies only string fiber-optic cable between wiring closets, in which case the fiber could be used for a backbone network while twisted-pair goes to the desktop. Others string fiber-optic cabling to every desk. The installation itself is so expensive, says Walker, that the incremental cost of the materials is not a factor.

Moreover, fiber-optic cable can be easier to install than standard cable, especially coaxial cable, says Walker, because it tends to be lighter and more flexible. Local building codes may also be less stringent for fiber-optic cable.

Fiber LANs

When people talk about fiber data networks, they're generally talking about FDDI. (It's also possible to run Ethernet or Token Ring protocols over fiber-optic cable and to use some proprietary networks.) Products that support FDDI have been coming out slowly for several months, and FDDI networks have been featured at a number of recent computer shows.

Like Token Ring, FDDI employs a ring-shaped topology and an electrical "token" to pass control of the network from one station to another. However, FDDI is not compatible with Token Ring. Most FDDI networks today use a double-ring structure where each node is attached to two separate rings, transmitting data in opposite directions. This improves reliability as well as speed, because if one ring goes down, the other can keep transmitting. Connecting to two rings is more costly, however, so current development efforts are aimed at products that will allow systems to connect to a single ring.

At this point, FDDI is used primarily to connect high-speed PCs or workstations to networks, or as a backbone to link other slower networks—just as a highway links neighborhoods—according to Walker. Workstations that are connected directly are generally performing intensive graphics and imaging applications, massive file transfers, or solid modeling.

Connecting to FDDI is expensive, due to the high cost of the optical components, as well as the cost of the transceiver and the FDDI chip set. For the price to come down, volume will have to increase, says Walker—and volume won't increase until the price comes down. He also thinks that some technology breakthrough may be required before prices come down.

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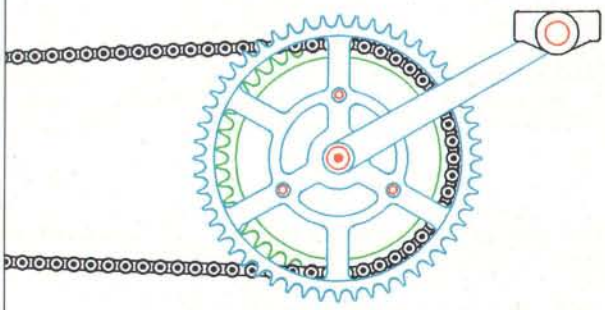

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Broadband Fiber

Beyond FDDI, several standards are under development that will allow you to transmit new types of data much faster than you can now. To begin with, there's FDDI 2, a second version of FDDI that will support voice and video as well as data. Unlike today's FDDI, which has an independent clock rate, FDDI 2 will have a frame rate of 125 microseconds, allowing it to be synchronized with the communications network, Walker says.

The communications network itself will be undergoing a fiber upgrade in the 1990s, says Dan Spears, research manager for advanced transmission switching systems for BellSouth Services in Atlanta. While some transmission is being done now over fiber, a number of data communications companies and Bell operating companies are working on defining Synchronous Optical Network (standardized optical interfaces to the fiber network). SONET would let you put one company's transmission and switching equipment on one end of the fiber and another company's equipment on the other.

SONET could transmit two types of signals: DS1 (digital signal 1) and DS3, which support transmission at 1.5 Mbps and 45 Mbps, respectively—the same rates T1 and T3 leased telephone lines use today. SONET would use what is called STS1, for synchronous transport signal 1, which transmits at 51.84 Mbps. Counting various types of overhead and management data, Spears says that STS1 is just right for transporting one DS3 signal or about 28 DS1 signals.

In addition, the SONET signals themselves can be combined into larger channels. For example, combining three of them results in a channel with a capacity of about 155.52 Mbps. And that speed will be the fundamental rate for broadband ISDN, Spears says.

The Big Picture

Broadband ISDN is an attempt to support the many different types of communications in use today with one network. These types of communications include

- *data*, which ranges from low speeds for alarm systems, to 1200 or 2400 bps for terminals, to 10 Mbps for LANs, to 100 Mbps for FDDI;
- *voice*, which generally uses 64,000 bps but can compress to 32,000 bps or support higher-quality rates of 192,000 or 384,000 bps; and
- *video*, which currently runs at about 45 Mbps. In Europe, it runs at 34 Mbps and might, with high-definition TV, require the full 155-Mbps channel. This is where the 155-Mbps figure for broadband ISDN comes from.

And those are just the ones we know about today.

Broadband ISDN will be able to transmit information of many different types using a multiplexing and switching principle known as ATM, for asynchronous transfer mode. As with X.25, information will be sent in bunches, called *cells*—5 bytes of header and 48 bytes of message. The header carries a channel number that tells the receiving node what kind of data the other 48 bytes contain.

This encapsulation will allow one network to support both the old transmission methods and the new ones that come along without having to change the network—and without the standards bodies

continued

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having to agree on how to do it. As it is, these bodies are expediting the standards process for broadband ISDN, so the standard will come out this year rather than four years from now.

The Potential of Fiber

One new service possible on broadband ISDN is switched multimegabit data service, or SMDS, which would link two networks over a public network with equipment supporting the IEEE 802.6 (metropolitan area network) protocol. Today, you generally have to lease a T1 or T3 line to link remote LANs; SMDS will let you connect the two LANs over a public switching facility. This would be more efficient for smaller customers.

The SMDS service might be available from regional Bell operating companies within local access telephone areas, or LATAs, as soon as 1991 or 1992, Spears says. Phase 2, a few years later, will link local SMDS switches via interexchange carriers, the same way that local phone systems are now connected via AT&T, MCI, and Sprint.

A pilot program under way in Heathrow, Florida, also demonstrates what might be available in the future. A fiber cable supporting 435 Mbps goes into each home. Of that, three 108-Mbps channels (i.e., a total of 324 channels) are devoted to video, while the remainder can be used for voice and data (see the text box "On the Threshold of a Dream" on page 234).

Necessary and Sufficient

To get such services, several factors need to come together: standards, equipment from the switching companies, fiber for the regional Bell operating companies, and tariffs (charges) from the local regulatory agencies. The standards bodies are working to speed up the standardization process. Spears says that some of the switching companies will be ready as soon as 1992 or 1993, while others will be ready by 1995. He notes that Southern Bell predicts that it will be all fiber within 20 years. But it's the tariffs that will eventually determine just what services are available, and for how much.

In the meantime, though, if you or your organization plans to use these new services, you need to begin thinking about how you can introduce fiber into your communications diet, and how you can do it as inexpensively as possible. ■

Sharon Fisher is a San Francisco–based freelance writer specializing in computer communications. She can be reached on BIX as "sharonfisher."

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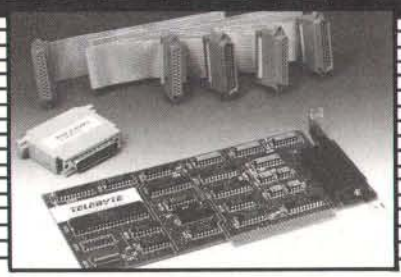

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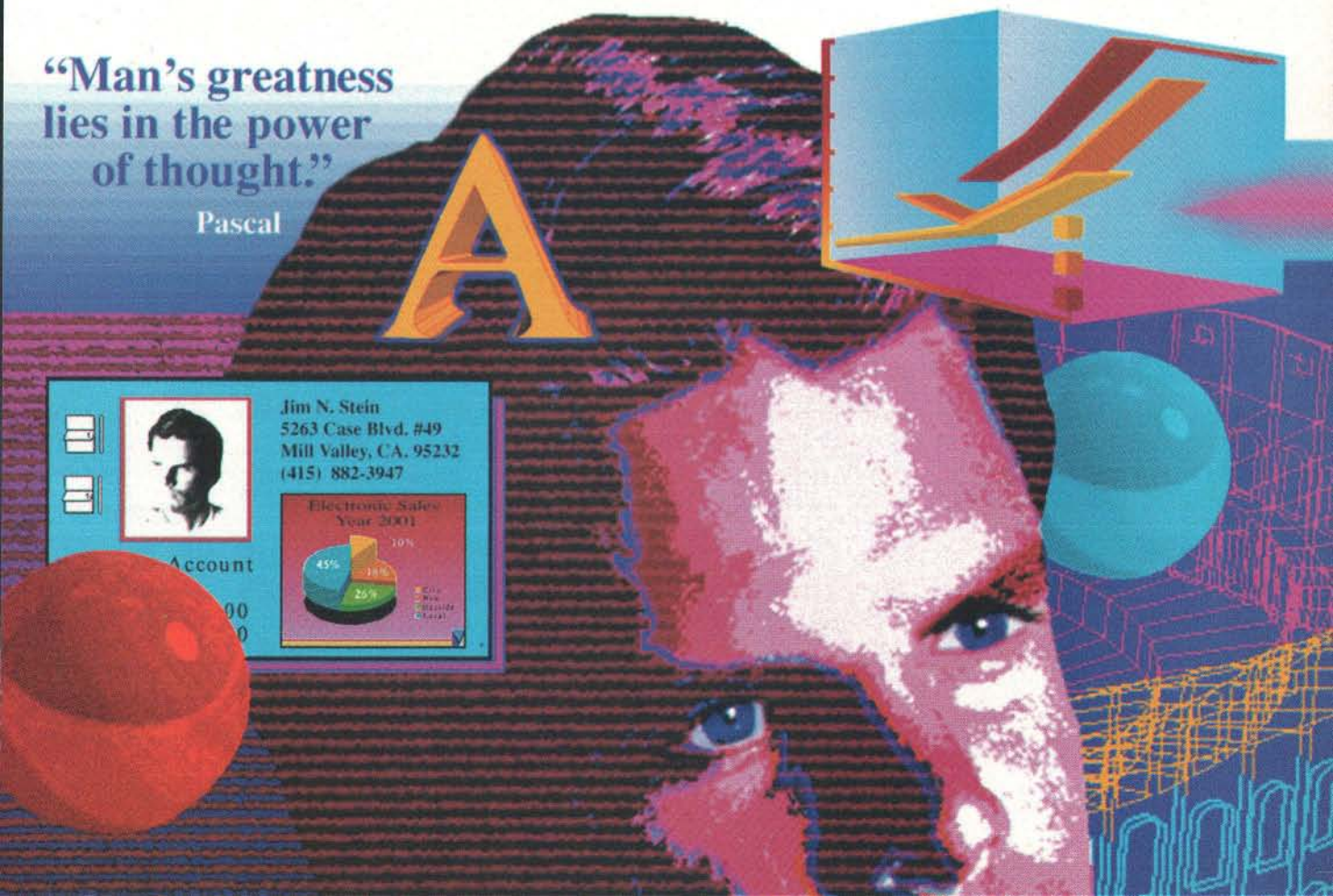

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Primed for Performance

If your network isn't hitting on all cylinders, tune up the resource allocation, and you'll have it purring like a Jag

Tad Hogg

How can you manage the various resources that are available on a network for a wide range of tasks? More and more organizations are turning to distributed processing. But managing a distributed system involves balancing a varying need for resources against a changing (and often unpredictable) computing environment.

Resource allocation displays a wide range of behaviors (e.g., oscillations, chaos, and equilibrium) in biological ecosystems and human economies—and in networks, as well. Thus, these behaviors, along with some AI techniques, can provide a basis for designing systems that effectively manage the capabilities and resources of distributed computer networks.

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Resource Management

A scheme to manage a variety of tasks must deal with several properties of network resources:

- The available resources continually change as machines are added to the network or become temporarily unavailable. Similarly, new programs and software updates aren't installed everywhere at the same time, so the system has to function with multiple versions of software.
- When machines with different capabilities are part of the network, tasks should be automatically assigned to the most appropriate machine. Various machines have different owners and costs, with associated restrictions on the kinds of programs that you can run on them.
- You may have different criteria for managing your tasks than someone else has. These preferences help to determine whether a task should run on a faster, more expensive machine, or on a slower, less expensive one.
- An appropriate management scheme also has to be able to decide what algorithm to use; for example, a simple, fast, keyword match or some more-complex analysis to retrieve text in a particular task. The complex analysis may be more accurate, but it is likely to require more processing time and will therefore cost more to use.

With these characteristics in mind, how can programs started on your personal machine locate the resources they need? One way is to send a task description to a central controller that monitors available resources and matches them with tasks.

Central Control

In most existing computers, the operating system performs the function of central controller to allocate CPU time, disk

continued

Swing Low

Oscillations in performance—or even irregular, chaotic behavior—can occur when the number of processes using particular resources continues to vary. Continued variation means that the system spends relatively little time near its optimal performance. Thus, its overall performance drops significantly. For a typical system comprising many processes with a mixture of cooperative and competitive payoffs, the range of behaviors for various levels of uncertainty and delay is summarized in figure A (see reference 10).

Although this model is highly idealized, it does indicate the range of possible global behaviors for these systems. It also suggests some simple approaches to eliminating the problems. For instance, when the system continues to oscillate, increasing the uncertainty will move it to a stable region. While improving the oscillatory situation, the deliberate increase in uncertainty means that the processes are ignoring some available information.

As an extreme case, if the processes select between two resources by randomly flipping a coin, a large system will reach an equilibrium with about half the processes using each resource at any given time. Thus, it would be quite stable. However, this method completely ignores any real differences between the machines. It would be far from optimal if they differ significantly in capability.

Another approach is for the processes to choose between the two resources more slowly so the information delays are less important. Although this method removes the oscillations, it makes the system less responsive to change (e.g., due to machines going down or new capabilities being added to the network).

A more sophisticated technique is for the processes to use the past behavior of the system to better estimate the respective payoffs of the available choices. This technique is similar to a technical analysis of market behavior. For example, when the system is in a mode of simple oscillation, a process that could determine the period of the oscillations could extrapolate from past information and remove the effect of the delay from its decisions.

This method is quite successful if only a few processes use it (see figure B). Predictive processes dramatically improve their individual performance and, by reducing the size of the system

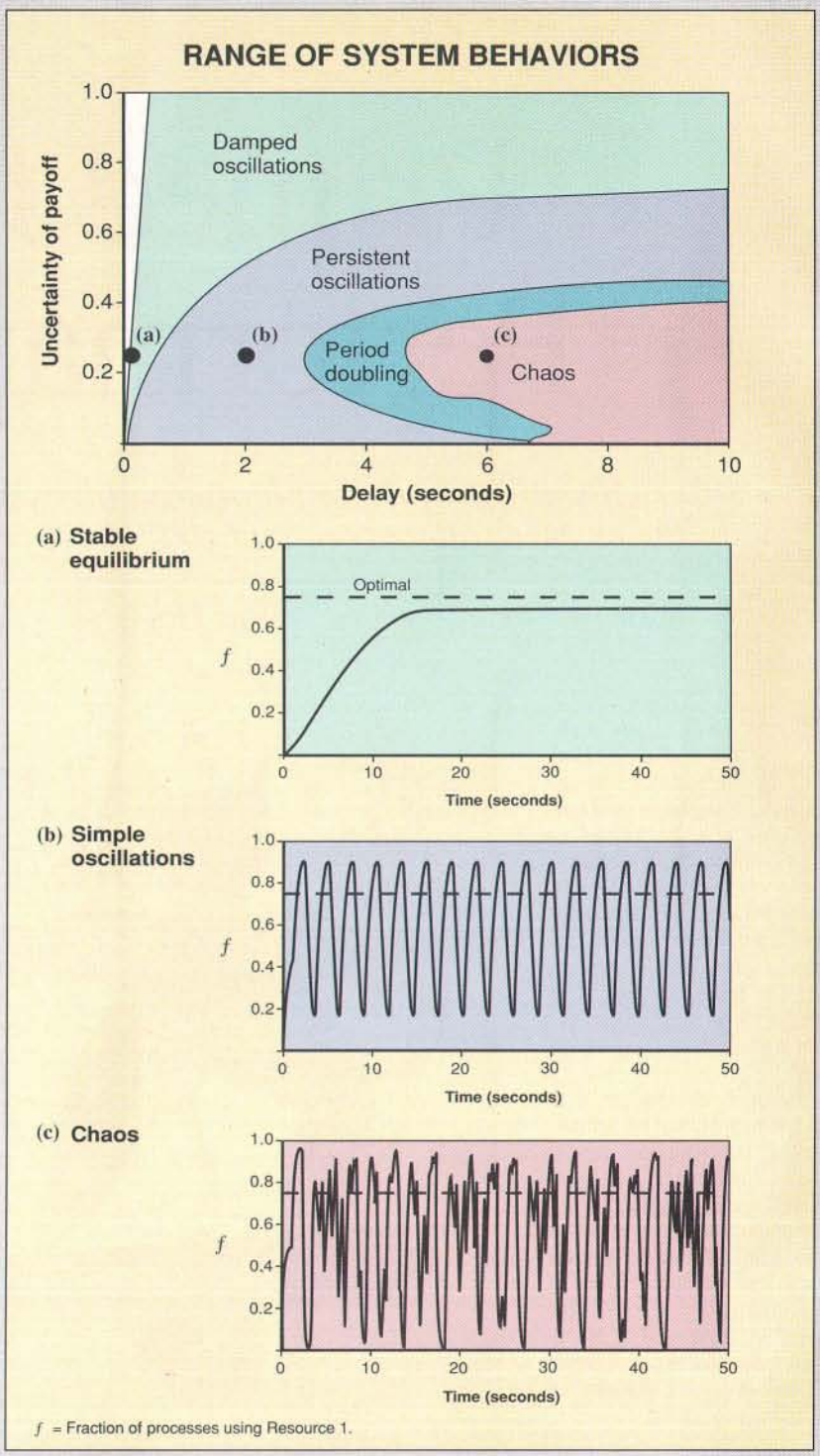

Figure A: *The range of behaviors for a computational ecosystem in which processes choose between two resources. In the unshaded region, the system does not oscillate, but relaxes to equilibrium. Typical behaviors for the fraction of processes using Resource 1 as a function of time are shown for three particular points:* **(a)** *relaxation approaching a stable equilibrium,* **(b)** *simple persistent oscillations, and* **(c)** *chaotic oscillations. The dashed line represents optimal resource allocation.*

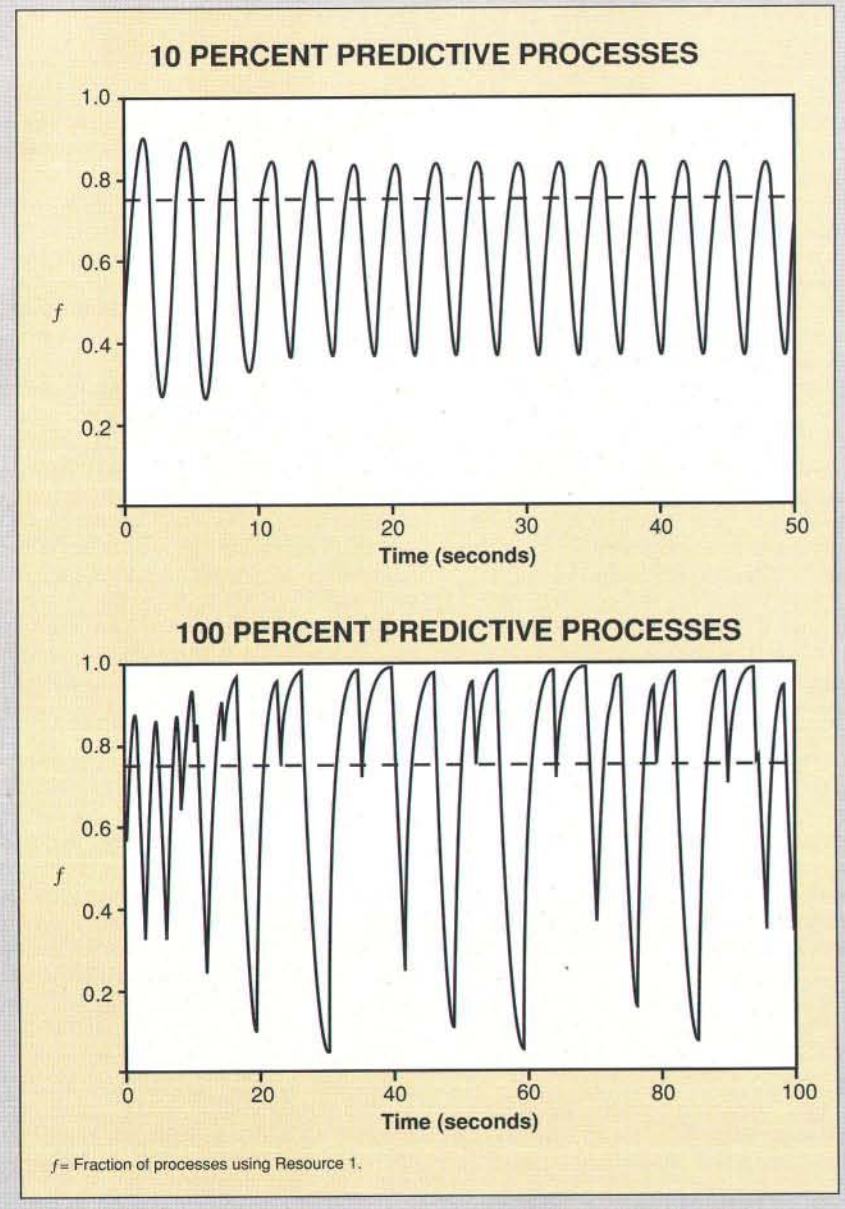

Figure B: *The fraction of processes using Resource 1 as a function of time where simple processes give rise to persistent oscillations. In the two plots, 10 percent and 100 percent of the processes, respectively, use simple estimates of the oscillation period to aid in their evaluation of the payoffs. The dashed line represents the optimal resource allocation.*

oscillations, slightly improve the performance of the nonpredictive processes as well. Unfortunately, as more processes use this technique, the dynamics of the system change markedly. The results are larger oscillations and lower overall performance.

At the opposite extreme are techniques that originate in game theory, which work well if all the processes adopt them and if they are aware of the exact resource needs of all the other processes (see reference 11). However, if stringent requirements are not met—and they probably wouldn't be in large networked systems—these techniques fail. Recent studies have shown that a hybrid approach might work in some cases (see reference 12), but the design of general, robust techniques for dealing with oscillations remains an open question.

I/O, and other resources to several different processes sharing a single machine. In a tightly coupled parallel computer, a carefully constructed compiler can provide a reasonable allocation of tasks to the various processors.

For these approaches to succeed, you need to understand the capabilities of the various machines and the particular needs of the tasks. Unfortunately, neither of these criteria is met for large, heterogeneous networks.

For instance, in a heterogeneous network, information about each machine's load and the resource needs of any waiting tasks must be transmitted continually to the central controller. This puts a significant communications load on the system. Then the scheduler must find a good match between the many possible combinations of tasks and machines and broadcast its instructions in a timely manner.

Relying on a single central computer to perform resource allocation places you in an either/or situation. Either the entire system depends on the continued functioning of one machine, or another machine must be set up to detect failures and assume the scheduler's role when a failure occurs. Thus, centralized control of a network is not the most efficient method of allocating resources.

Local Control

Reliability and rapid response to local changes require that resources be controlled locally and autonomously. Decentralizing resource allocation allows tasks to run on many different machines and manage the resources collectively.

While processes can immediately access the load on their own machines, they can't always access other parts of the network as fast. Delays in receiving information that is needed to make decisions can occur, or the information may be incorrect or inconsistent.

On a network, delays can be due to a variety of causes: the time required to transmit signals, a crashed node that forces a search for an alternate path, or other hardware limitations. Incorrect information can come not only from hardware faults but also from computations that use probabilities, heuristics, or rules with a variety of exceptions. Moreover, when a single task uses several information sources, they sometimes give conflicting results.

An individual resource-allocation program must be able to operate in an unpredictable environment that consists of various machines and users. This means

continued

that many changes will be beyond the program's control and will lead to incomplete, incorrect, conflicting, and changing information. These characteristics present problems for distributed software systems.

Computational Ecosystems

Although the hardware necessary to support a wide range of new tasks is rapidly being developed, major software issues remain. How can large collections of locally controlled, asynchronous, and concurrent processes interacting with an unpredictable environment be programmed effectively?

This practical question raises some more basic ones (see reference 1). How does the overall behavior of such a system relate to the local behavior of its individual machines? Are there any laws that apply to the development of these systems and their adaptability to change?

These questions extend well beyond the task of managing resources in a network. In fact, the problem of designing programs to operate in an unpredictable environment occurs in many AI systems, as well.

AI systems are expected to handle a wide range of problems and rely on various heuristic methods, because direct methods are either unknown or prohibitively slow to use. Novel problems and the occasional incorrect choices that the heuristics make cause the system's individual components to behave unpredictably. More complex cases concern systems that interact with the physical world or where many "agents" must coordinate their activities to adequately address a problem.

Some insight into these software issues is provided by existing systems that also face this fundamental problem: How do you coordinate a large group of independent processes, each of which makes decisions based on its own limited and imperfect view of the world? These existing systems, such as the scientific community, biological ecosystems, and market economies, can be used metaphorically as a design model for a distributed, intelligent computer system. The agents become computer programs, or processes, that interact with each other and with an external environment defined by your requests and sensor inputs. These interacting processes form a *computational ecosystem*.

A number of computational ecosystems have been studied (see references 2 and 3), including economic models. They rely on individual machines and tasks to make decisions based on locally available information, combined with a decentralized mechanism to achieve overall coordination of the network.

Market Economies

Allocating resources to competing tasks is a key issue in using computer networks effectively. Examples include deciding whether to run a task in parallel on many machines or serially on one, and whether to save intermediate results or recompute them as needed.

The similarity of this problem to resource allocation in market economies has prompted a considerable amount of interest in using similar techniques to schedule tasks in a network environment. In effect, you can solve the allocation problem by using Adam Smith's "invisible hand" (i.e., organized activity emerges in an unregulated market economy as if a central agency, or invisible hand, were in control; see reference 4). Although it's unlikely to produce the optimal allocation that would be made by a central controller with unlimited computational capability, this approach works well compared to other alternatives (see reference 5).

Using prices provides a flexible mechanism for allocating resources without requiring much information. A single price summarizes the current demand for each resource, whether it is processor time, memory, communications bandwidth, use of a database, or control of a particular sensor.

This summation is especially desirable when resource preferences and performance measures differ among tasks. For instance, an intensive numerical simulation's need for fast floating-point hardware is quite different from an interactive text editor's need for rapid response to user commands. It is also quite different from a database search's need for rapid access to the data and fast query matching.

The Price Structure

A number of market-like systems have been implemented over the years. Most of them focus on finding an appropriate machine for running a single task. While this is important, some systems provide further flexibility by also using market mechanisms to manage a collection of parallel processes working to solve a single task.

In the latter case, prices provide a flexible method for allocating resources among multiple heuristics competing for the same problem. This method greatly simplifies the development of programs

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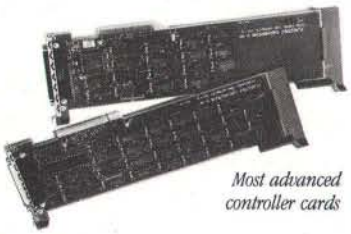

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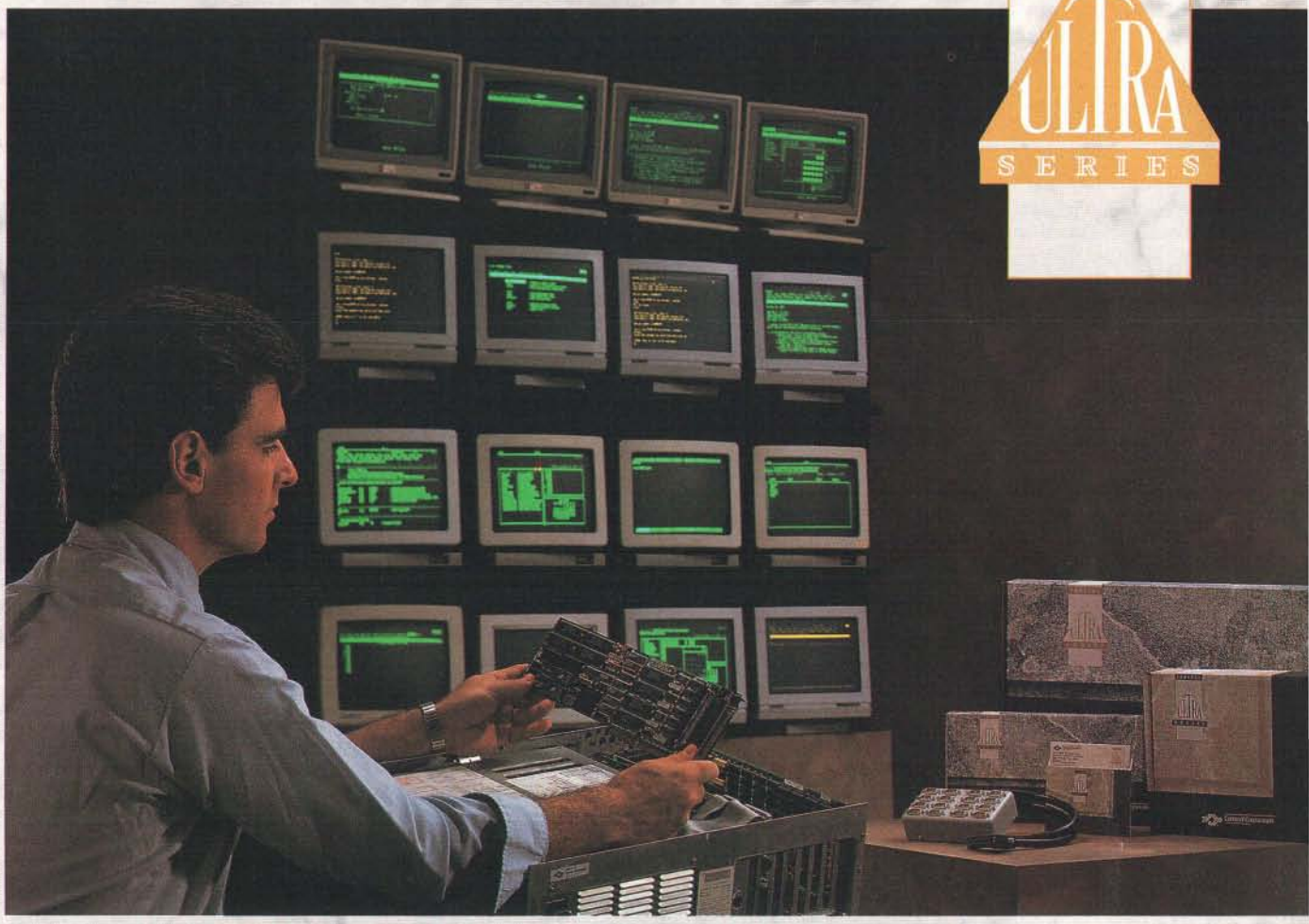

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that must adjust to unpredictable changes in resource demand or availability.

One such system is Spawn (see reference 6). In Spawn, each task starts with a certain amount of money that corresponds to its relative priority and bids for the use of machines on the network. Thus, each task can allocate its budget toward whatever resources are most important to it. In addition, when prices are low enough, some tasks can split into several parts that run in parallel, thereby adjusting the number of machines devoted to each task based on the demands of other users. Studies with this system show that an equilibrium price can be defined even if only a few machines participate (see reference 7).

Fine-Tuning

You can use market systems to experimentally address a number of additional issues. For instance, they can help you understand what happens when more sophisticated programs (e.g., processes that attempt to anticipate future loads to maximize their own resource usage) begin to use the network: They can destabilize the whole system.

Another interesting area is how diversity, or specialization, can emerge from a group of initially similar machines. For example, a machine might cache some of the routines or data commonly used by its processes, giving it a comparative advantage in bids for similar tasks in the future.

Ultimately, this ability to adjust could result in complex organizational groups embedded in a larger framework (see reference 8). Within these groups, some machines could keep track of which machines are best at handling which kinds of problems and could use this information to match each task to the right machine. Thus, the system could gradually "learn" to perform common tasks more effectively.

In addition, these experimental systems help to clarify the differences between human and computer markets. As an example, computational processes can respond to events much more rapidly than people can, but they are far less sophisticated.

Moreover, you can build particular incentive structures, rationality assumptions, and so on into computational processes that make it possible to design particular market mechanisms. You cannot do that with people. The irony is that economic theory can predict the behavior of computational ecosystems better than it can predict that of the larger, and more complex, human economy.

These techniques provide the flexibility to respond to many variations of networks, and they are relatively simple to implement. They are also much more robust than central controllers since no one machine is necessary for the network to function.

What's the Payoff?

While existing systems can be useful guides, it's also important to clarify the overall behavior of computational ecosystems, particularly since even simple mechanisms can lead to unexpectedly complex behavior (see reference 9).

At a fundamental level, a computational ecosystem consists of a number of processes that must choose from among various resources to accomplish their tasks. These may be hardware resources, such as execution time on a computer or

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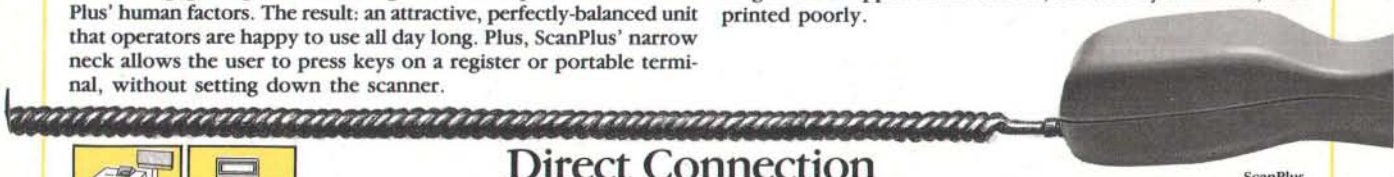

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the use of a communications line, or software resources, such as using proprietary programs or accessing various databases.

Since decisions aren't centrally controlled, the processes independently select from the available choices based on the perceived *payoff* for using each one. Payoffs are measures of performance, such as the time required to complete a task, the accuracy of the solution, or the amount of memory required. For example, a numerical simulation might evaluate resources based on how many millions of floating-point operations they deliver. Due to the various interactions that occur among the processes, the payoff for using a given resource also depends on the number of processes that are already using it.

In a purely competitive environment, the payoff for using a resource decreases as more processes use it. As an alternative, the processes using a resource can assist one another in their computations (e.g., by breaking an overall task into a number of subtasks).

If the subtasks need to communicate extensively to share partial results, the processes might do better to use the same computer rather than using faster separate machines and being limited by slow communications. In such cooperative situations, a resource's payoff increases as more processes use it, until it becomes too crowded.

Imperfect information can cause perceived payoffs to differ somewhat from actual payoffs. The difference between them increases as uncertainty in the information increases. This simple uncertainty model captures the effect of many errors, such as program bugs, heuristics incorrectly evaluating choices, and errors in communicating the load on various machines to each process.

In addition, due to delays in receiving information, each process's knowledge of the state of the system is somewhat out-of-date. For the sake of simplicity, the following examples involve processes that have the same effective delay and uncertainty and that choose between two resources. However, the same range of behaviors also applies to broader models (see reference 10).

When the delays and uncertainty are slight, the system performance converges to an equilibrium point that is close to the optimum that a central controller can obtain. However, when the information is more corrupt, the equilibrium point moves further away from the optimum, and it can become unstable. (To explore the effects of this oscillation, see the text box "Swing Low" on page 242.)

An Evolving System

As a computational ecosystem evolves, not only will the processes adjust their choices of resources, but the external environment will also impose changes. For instance, if new machines and databases are added to the network, the relative payoffs of the resources will change.

How readily can the system as a whole adapt to such changes? Processes that use simple competitive payoffs have the ability to determine the benefit of any new resource and use it accordingly. However, a couple of conditions can hamper the transition:

- if the processes are cooperative (i.e., each process is unwilling to use a new resource unless many others are already using it), or
- if the transition overhead is high (e.g., because previously developed complex organizational structures must be modified).

One approach is for processes to estimate future payoffs as well as current ones. With these estimates, processes could make changes that appear undesirable initially to reap higher payoffs in the future.

Another approach is for groups of processes to develop coordinated plans to take advantage of the new opportunity. Techniques for automatically negotiating such plans form one of the key research issues for distributed AI systems (see reference 11).

Taking Full Advantage

Devising software systems to take advantage of the capabilities that are provided by emerging networks is a real challenge. Such programs must deal with a large, changing environment.

The systems that result are analogous to biological ecosystems and human organizations. A study of these systems' models provides insight into their complex range of behaviors, and it uncovers some general guidelines for network design.

This analogy also raises additional questions. For instance, what is the relationship between the organization of a system and its adaptability to new situations? One interesting possibility is that chaotic systems might actually maintain a higher degree of adaptability than do systems that have fixed equilibriums. Although chaotic systems are further from the optimum, they continually sample different combinations of states.

In addition, the way in which overall performance is distributed among the individual processes might determine how rapidly the system can improve through specialization. Finally, studies of computational ecosystems may also shed light on various theories relating to the

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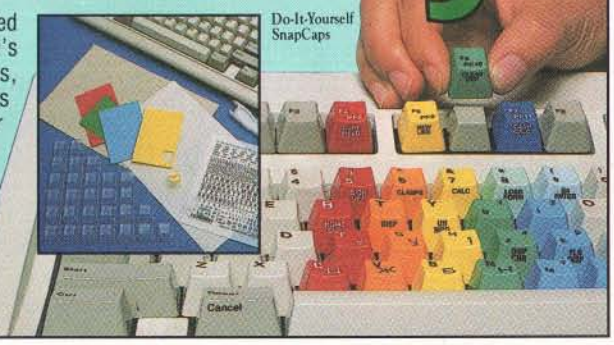

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behavior of their biological and economic counterparts. ■

ACKNOWLEDGMENTS

The research results summarized here come from my collaboration with the members of the Dynamics of Computation group at Xerox PARC, particularly Bernardo Huberman and Jeffrey Kephart, as well as Carl Waldspurger of the MIT computer science department.

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As networking and communications become more important in all aspects of computing, the number of concepts and acronyms you need to know seems to grow exponentially. Listed below are many of the products and concepts discussed in this section. Included are addresses and phone numbers to let you continue your investigation into networking issues.

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Inquiry 1051.

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Standards Institute (ANSI)
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Brooklyn Bridge
Fifth Generation Systems
10049 North Reiger Rd.
Baton Rouge, LA 70809
(800) 873-4384
Inquiry 1053.

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Server Technology, Inc.
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Santa Clara, CA 95051
(408) 988-0142
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FastLynx
Rupp Corp.
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Los Angeles, CA 90046
(213) 850-5394
Inquiry 1055.

FlashTalk
TOPS
TOPS
P.O. Box 4026
Alameda, CA 94501
(415) 769-8773
Inquiry 1056.

GOSIP Users' Guide
(Special Publication 500-163)
National Institute of Science
and Technology
5285 Port Royal Rd.
Springfield, VA 22181
Inquiry 1057.

LANLink 5X
The Software Link
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Norcross, GA 30093
(404) 448-5465
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LANtastic Z
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Tucson, AZ 85704
(602) 293-6363
Inquiry 1059.

Local Area Transport (LAT)
Digital Equipment Corp.
146 Main St.
Maynard, MA 01754
(508) 493-5111
Inquiry 1060.

LU 6.2
NetView
IBM Corp.
Old Orchard Rd.
Armonk, NY 10504
(914) 765-1900
Inquiry 1061.

Model 24
Bay Technical Associates, Inc.
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(800) 523-2702
Inquiry 1062.

NetCommander
Digital Products, Inc.
108 Water St.
Watertown, MA 02172
(800) 243-2333
Inquiry 1063.

NetWare 386
Novell, Inc.
122 East 1700 South
Provo, UT 84606
(801) 429-5900
Inquiry 1064.

Network OS
CBIS, Inc.
5875 Peachtree Industrial Blvd.
Building 100, Suite 170
Norcross, GA 30092
(404) 446-1332
Inquiry 1065.

OS/2 LAN Manager
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(800) 231-0900
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(201) 592-6874
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Banyan Systems, Inc.
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Westborough, MA 01581
(508) 898-1000
Inquiry 1070.

ZeroNet
U.S. Marketing
1608 17th Ave. S
Nashville, TN 37212
(615) 269-9071
Inquiry 1181.

This resource guide is intended to provide a reasonable cross-section of available products, companies, and services; due to space limitations, we cannot list all companies and products. Inclusion in the resource guide should not be taken as a BYTE endorsement or recommendation. Likewise, omission from the guide should not be taken negatively. The information here was believed to be accurate at the time of writing, but BYTE cannot be responsible for omissions, errors, or changes that occur after compilation of the guide.

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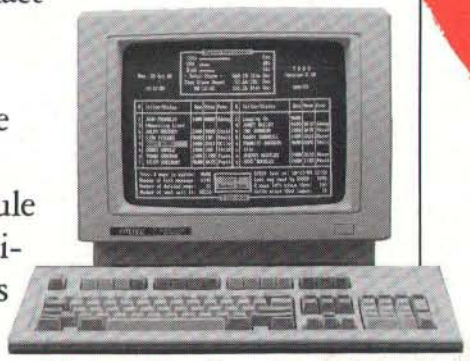

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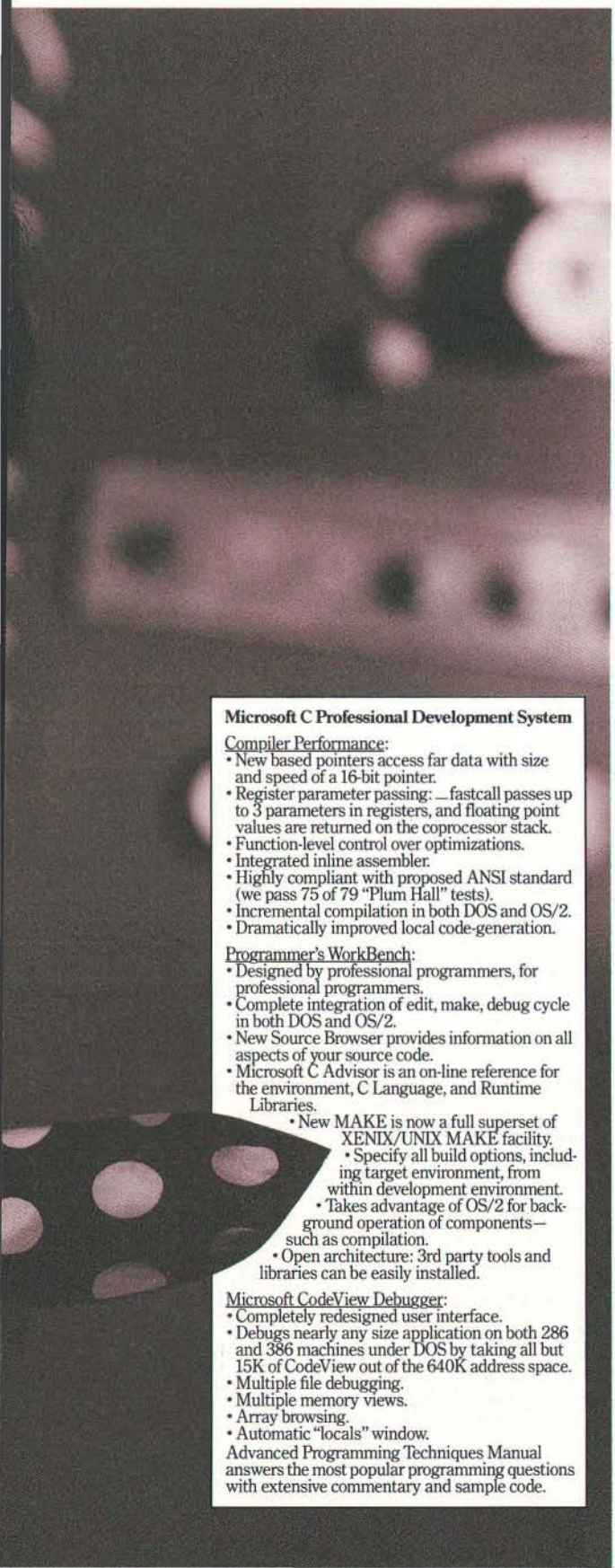

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IMAGES FROM THE DEEP

David A. Mindell

Oceanography is a dark science. Like astronomy, it is the study of a void, overwhelming to behold and hostile to human life. In such fields, improvements in instrumentation often determine the progress of science. The evolution of ocean instruments able to function in the highly pressurized, corrosive, conductive environment has been a key element in the advancement of our knowledge about the deep.

The Deep Submergence Laboratory of the Woods Hole Oceanographic Institution performs research regarding deep-ocean vehicles and instrumentation (see the photo). Headed by scientist Dr. Robert Ballard, DSL's previous work with deep-ocean vehicles includes the discovery of the *Titanic* 3800 meters below the surface, and the *Bismarck*, 4700 meters down (see "Finding the Titanic," March 1986 BYTE).

Manned instruments, in the form of submarines like ALVIN (a manned research vessel operated since 1964 by Woods Hole), provide exciting insights into the deep-ocean environment. But technology is moving toward remotely operated vehicles. ROVs are safer and less expensive to operate than manned vehicles and can stay submerged for days and even weeks, compared to 8 to 12 hours for manned submersibles.

Most recently, DSL's personnel have designed and built a deep-ocean ROV called Jason (see figure 1), named after the mythical argonaut who searched for the Golden Fleece. It is among the first ROVs designed from scratch to take advantage of the communications and control possibilities created by fiber-optic cables.

The Jason Project

Among other undertakings, DSL employs the Jason ROV in an educational program known as the Jason Project. The program's goal is to expose students to the excitement of the sciences and engineering, hoping to spark their interest in learning about the undersea world.

The Jason Project uses the vehicle to perform an annual series of underwater dives and to televise live pictures from the ROV to over 400,000 North American students visiting science museums. These are fully interactive shows transmitted over two-way satellite links. The school children watch the research as it takes place and can ask Dr. Ballard questions.

Students participating in the project literally can have hands-on experiences, actually operating the vehicle from their remote sites. Joysticks and graphical user interfaces are connected over the satellite network directly to the vehicle computers. In this way, pupils can direct their own exploration of televised wrecks. Simultaneously, they can see the results of their actions on real-time data displays.

Woods Hole carries out its Jason Project explorations via a vehicle system consisting of the Jason ROV and a smaller camera sled called the Medea (named after Jason's wife) connected to a surface mother ship (see figure 2). Jason and Medea provide video, data, and sonar images to the mother ship, which houses scientists and engineers who coordinate the vehicles and process the data on computers. The mother ship also contains transmitters that send data from the ocean to remote sites via a satellite uplink.

An electro-optic cable containing electrical power lines and three single-mode optical fibers connects Jason through Medea to its mother ship. The ROV can dive to 6000 meters and move with its own thrusters for extended periods of time. The Medea hangs between Jason and the mother ship to absorb the tremendous loading forces of a long cable connected to a pitching vessel. It also provides lights and video so Jason's operators can monitor its movements.

On-Board Computers

All high-level computation is performed by 386-based microcomputers on the surface ship. These tasks include vehicle control, manipulator control, ship movements and navigation, and data logging. Scientists do not entrust critical computations to the subsea vehicle computers because of their remote nature—they operate under constraints of power, space, and limited

continued

The Woods Hole Jason Project uses a unique vehicle system and a fiber-optic network to transmit data from under the sea

ILLUSTRATION: E. PAUL OBERLANDER/COURTESY WOODS HOLE OCEANOGRAPHIC INSTITUTION

accessibility. Subsea computer tasks include low-level monitoring, hardware control, data collection, and communications handling: "smart multiplexing." With most computers on the surface, software development for Jason can be performed on standard machines separate from the vehicle itself.

The topside Jason computer runs VRTX (for virtual real-time executive multitasking operating system), which monitors the vehicle systems, receives information from the operator's handbox and joystick, and performs control calculations to send the required commands back down to the vehicle. This computer also formats and sends vehicle-monitoring informa-

In 1989, Jason surveyed and excavated a fourth-century trading vessel lying 700 meters deep in the Mediterranean sea. Here the vehicle employs a specially designed robot arm to recover an amphora, or large vase, from the wreck. (Photo courtesy Quest Group, Ltd., and Woods Hole Oceanographic Institution)

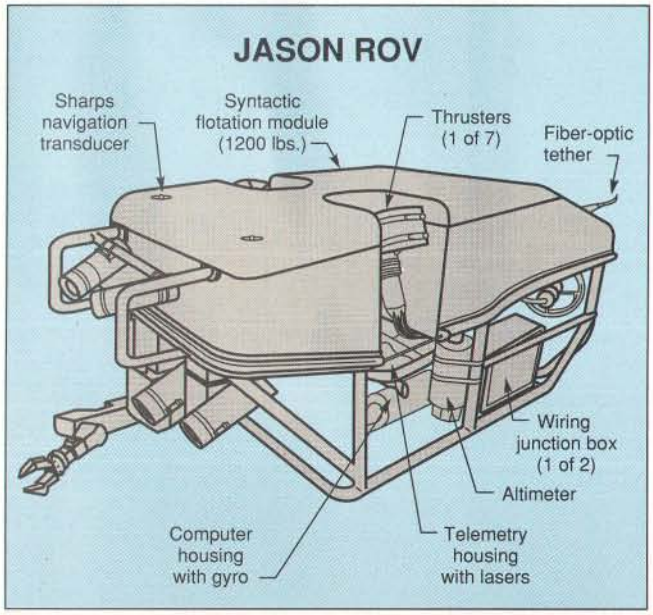
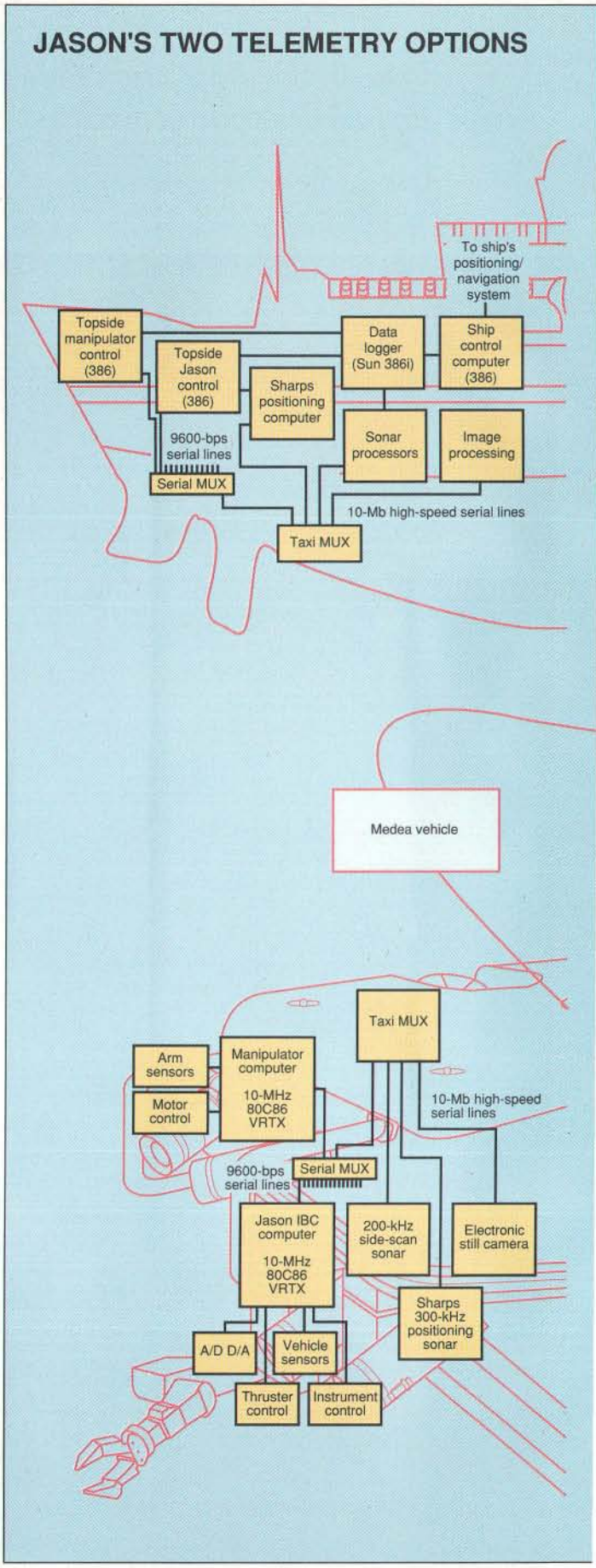


Figure 1: *Connected by a fiber-optic cable to a mother ship, Jason maneuvers using a set of seven thrusters to perform deep-sea research. Note the extensive array of video cameras, the remote manipulator arm, and other assorted sensors.*



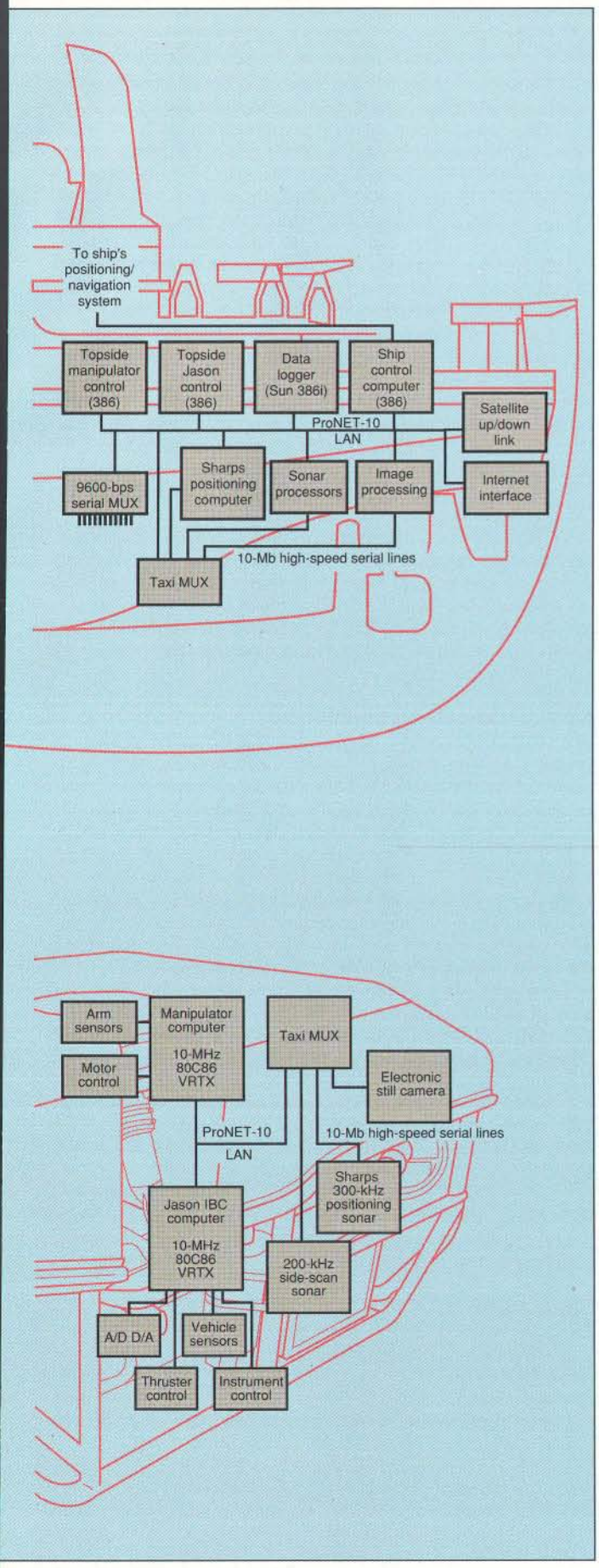


Figure 2: *Two different methods of telemetry connecting the computer suite on the mother ship through the Medea camera ship to Jason. On the left, standard serial lines connect Jason's computers, while on the right, an updated scheme uses a LAN to connect system components. Both options use the fiber-optic cable, but the network telemetry shown at right addresses the vehicle as an actual node on a 10-Mbps LAN. This network can then be easily connected to other networks via a satellite link.*

tion to a Sun386i workstation, where its Exabyte tape drive logs it, along with sonar and ship data, for further analysis.

Benefits of Fiber Optics

Shallow-water ROVs tend to be tethered to a ship by regular coaxial cables. Power, telemetry, and video are frequency-multiplexed on electrical conductors. When deep-ocean work of several kilometers or more requires such long cables, attenuation severely limits signal bandwidth.

To overcome this problem, scientists use fiber-optic cables capable of faster and higher-quality data and video transmission. Laser-driven optical systems enable transmission rates in excess of 125 megabits per second. Such advanced types of data highways are transforming the science of telerobotics.

The wide bandwidth of fiber optics allows Jason to transmit data from multitudes of instruments and cameras. The ROV carries devices such as a side-scan sonar, an electronic still camera, and laser/sonar ranging systems. In addition, Jason carries two charge-coupled-device color video cameras and a broadcast-quality "three-chip" camera with a separate CCD for each primary color.

Jason video is digitally modulated and then multiplexed onto two of the three optical fibers. The third of the three optical fibers conducts bidirectional data telemetry for these instruments, control commands, and vehicle-monitoring functions. A specialized TAXI (for transparent asynchronous transceiver interface) chip, made by Advanced Micro Devices, multiplexes 10 10-Mb serial lines onto a single 125-Mb signal on the fiber. A TAXI at the other end then demultiplexes the signal back into 10-Mb lines.

Engineers at DSL are developing hardware and software architectures to make efficient use of such fiber-optic communications channels. Research areas include signal processing, imaging, and nonlinear distributed control. Each area requires incorporating the raw bit rate of the optical fibers into a standard, flexible, and reliable network computing environment.

Serial Telemetry

The original Jason system relies on standard serial lines to transmit commands and data. Two high-speed TAXI channels are multiplexed from 10-Mb to 9600-bps RS-232 and RS-422 serial lines. On the vehicle Jason, these lines connect directly to instruments or through control computers for the vehicle and the manipulator arm. Each computer is built around a special instrument bus computer (IBC), a 10-MHz 80C86 machine based on a standard multibus-derived backplane developed at Woods Hole for use in low-power oceanographic instruments.

The subsea IBC that performs primary vehicle control runs a version of VRTX that concurrently handles several responsibilities: vehicle monitoring, data communication, and closed-loop control tasks for piloting the vehicle. The most time-critical controller is a heading servo whose calculations run topside. It

continued

issues commands to the thrusters at about 5 to 10 Hz. This function keeps Jason on a given heading and reduces the human operator's workload.

Communications based on serial interfaces are conceptually simple and highly reliable. All data packets are sent in ASCII form with logical headers. An operator can debug serial streams at any point merely by viewing them on a terminal screen. Heading information, for example, might be contained in a packet of H270, meaning the vehicle is facing 270 degrees. Furthermore, programming tools for serial interfaces are simple and well developed. Each topside machine uses a Star Gate communications coprocessor to handle up to eight serial ports simultaneously.

These serial interfaces, however, become impractical past a certain level of speed and complexity. They might be acceptable in a standard research laboratory where a system is set up once and remains so for a long time. But the Jason system goes to sea three or four times a year, and technicians must set it up and organize it efficiently. The proliferation of point-to-point serial cables complicates such operations because of their sheer quantity.

Furthermore, as the system matures and its capabilities are extended, control and telemetry requirements exceed the 9600-bps, or even the 19,200-bps, limits of these serial lines. For example, the current average latency on the heading servo, or the time it takes for the vehicle to react to a disturbance in the environment, is about 180 milliseconds. This speed is adequate but not optimum. If the bandwidth were increased above 5 Hz, operators could control the Jason vehicle more precisely by making quicker course corrections.

Network Telemetry

For multinode environments, a LAN greatly simplifies interconnections. Furthermore, because of a LAN's flexibility and programmability, you can easily increase its capabilities with new configurations and added hardware.

But an ROV at 6000 meters below the ocean surface is far from a typical LAN application. To make a network function in this type of hostile environment, ocean engineers must modify and improve on existing technologies. Jason's requirements include a long cable run with no possibility of repeaters and limited space and electrical power on the subsea nodes. Also needed are high reliability and the capacity to operate in the event of damage to those nodes.

DSL evaluated several network structures to find one that would fulfill the requirements of the Jason application. DSL decided against using the Fiber Distributed Data Interface, because while it is specifically designed for fiber optics, the lab cannot commit the resources necessary to modify and support it. Furthermore, FDDI specifies the needs for repeaters every 2 kilometers. This type of repeater is not available for oceanographic cables. Similarly, standard Ethernet networks have 4-km limits.

The ProNET-10 from Proteon provides the nucleus of an appropriate and reliable solution for these problems. It uses 10-Mbps hardware and a token-passing scheme to prevent message-packet collisions. If a node fails, it removes itself from the network via a relay, providing good fault isolation.

DSL modified the basic network to suit the Jason application. This work included using Xylinx programmable gate arrays to design a board to fit into Jason's cylindrical pressure housing. The resultant network reduces message latency through the telemetry system from 90 ms to 5 ms. Overall, this system's data throughputs are about 65K bytes per second, an improvement of nearly two orders of magnitude over 9600-bps serial lines.

DSL also developed the software to support Jason's network. Since the VRTX kernel does not support any network interfaces, lab personnel modified a commercial TCP/IP package to operate in the VRTX environment. The use of a standard protocol like TCP/IP allows other computers on the network to use existing software. This network connects the topside computers not only to each other but also to the computers located underwater. DSL has created a flexible system in which any device can talk to any other device.

The Jason subsea computer interacts with the topside controller, and it also logs data to a Sun386i connected through an Ethernet gateway. Furthermore, the topside controller gathers data from the ship and vehicle navigation computers and provides position information to calculate the vehicle's control commands. In another configuration, a microcomputer simulates the Jason node, thus providing a shore-based network for software development. Without complex connection problems, DSL personnel can also arbitrarily add nodes to the network, using standard hardware and software.

TCP/IP also has a global effect. It lets the Jason network connect to other standard networks. For example, TCP/IP allows the use of gateways to satellite networks for transmission of ocean data to the shore in real time. With an additional gateway to Internet, the Jason vehicle could relay data and images from sea in near real time to scientific computing environments all over the world.

Scientific and Social Implications

Scientists will benefit from the inclusion of oceanographic research vessels in national computer networks. By allowing researchers to communicate with each other while at sea, such network connections improve the contribution of oceanographic research expeditions to the scientific community as a whole.

Not only can Jason transmit live pictures of underwater research to students, it could also transmit video and data to an auditorium of geologists, biologists, or historians. The capabilities of an ROV maintain the interactive nature of highly successful manned submersible operations while vastly increasing the opportunities for communication among researchers.

Developments in ocean research are influencing the social structures of communication. The Jason Project uses fiber optics and satellite links to integrate science, technology, and education. Through Jason's satellite link, students in science museums participate in the study of human and geological history on the ocean floor—"telepresence." The communications and networking capabilities of Jason and the Jason Project will make the wonders of the ocean more accessible not only to scientists but also to the larger community. ■

ACKNOWLEDGMENT

Thanks to DSL research engineer Bob Weiman for information concerning the Jason network.

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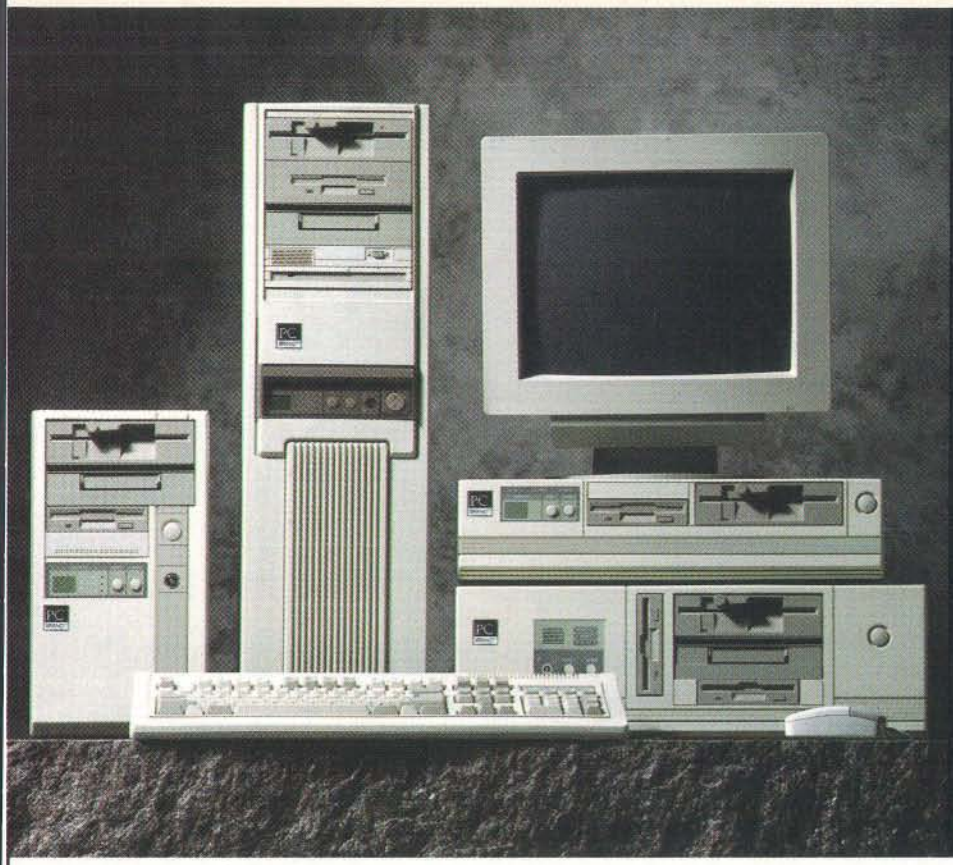
Yoerger, Dana R., James B. Newman, and Jean Jacques Slotine. "Supervisory Control System for the Jason ROV." *IEEE Journal of Oceanic Engineering*, vol. OE-11, no. 3, July 1986.

David A. Mindell is a writer and electrical engineer. He is a technical consultant to the Deep Submergence Laboratory of the Woods Hole Oceanographic Institution in Woods Hole, Massachusetts. He can be reached on BIX c/o "editors."



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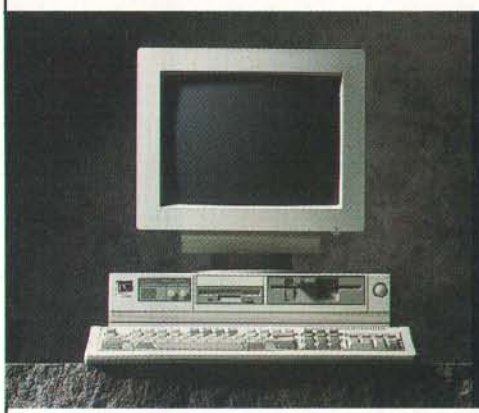

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20 MHz Clock, Zero Wait Operation,
Norton SI 23.0 Landmark™ Speed 26.7MHz,
512K RAM, 1.2MB or 1.44MB Drive, 101-Keyboard,
2 Serial and 1 Parallel Ports

Standard System Features:*

- 80286-12, 80286-16, 80286-20 operating at 12 MHz, 16MHz, or 20MH z w/Zero Wait
- 512K RAM expandable to 8MB on the System board using 256K or 1MB RAM
- 1.2MB 5.25" or 1.44MB 3.5" Diskette Drive
- FCC Class "A", Intended for business use
- High performance 16bit VGA Cards with optional 1024x768 capability
- 1:1 Interleaved Hard/Floppy Drive Controller, 1Mb/Second disk transfer rates on all 100Mb drives or larger
- Enhanced 101-key Click/Tactile Keyboard
- 2 Serial & 1 Parallel ports on std-configurations
- High Capacity System Power supply
- Real Time Clock/Calendar with 5 Year Battery
- 80287 Co-Processor Support
- AMI BIOS w/full MS/DOS, OS/2, XENIX, UNIX, NOVELL, 3COM and PCNET compatibility
- Built-in System Board LIM 4.0EMS hardware
- User configurable I/O timing permitting compatible operation w/older peripherals or faster I/O for newer devices
- 8 Slot motherboard design (5 16Bit & 3 8Bit)
- Medium foot print case w/6 Disk Drive bays

Options:

- Low profile Slim Line Case w/3 Disk bays (as pictured above)
- Mini Size desk top Tower* Case w/4 bays
- VGA or CGA Plasma Portable Case
- Factory Installed RAM Upgrades
- Custom configurations w/Name Brand peripherals of your choice

PC BRAND 286/12

w/512k, Hard Disk Drive, Monitor & Video Card

Hard Drives: Mb/Ms	20/40	40/19	66/25	100/25
No Video	$929	$1029	$1209	$1349
Mono	$1049	$1149	$1329	$1469
VGA-Mono	$1229	$1329	$1509	$1649
VGA-Color	$1459	$1559	$1739	$1879
SVGA/Color	$1569	$1669	$1849	$1989

PC BRAND 286/16

w/512k, Hard Disk Drive, Monitor & Video Card

Hard Drives: Mb/Ms	20/40	40/19	66/25	100/25
No Video	$1079	$1179	$1359	$1499
Mono	$1199	$1299	$1479	$1619
VGA-Mono	$1379	$1479	$1659	$1799
VGA-Color	$1609	$1709	$1889	$2029
SVGA/Color	$1719	$1819	$1999	$2139

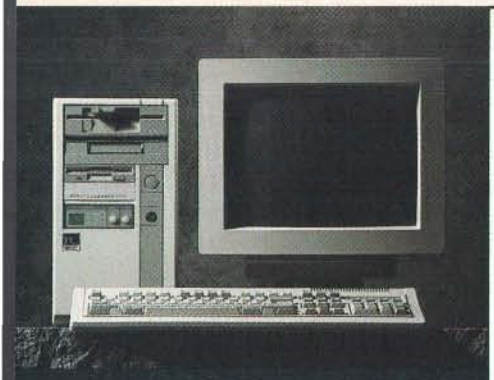
PC BRAND 286/20

w/512k, Hard Disk Drive, Monitor & Video Card

Hard Drives: Mb/Ms	20/40	40/19	66/25	100/25
No Video	$1229	$1329	$1509	$1649
Mono	$1349	$1449	$1629	$1769
VGA-Mono	$1529	$1629	$1809	$1949
VGA-Color	$1759	$1859	$2039	$2179
SVGA/Color	$1869	$1969	$2149	$2289

*Tower is a registered trademark of NCR Corporation

*Features below for 286/16 and 20 only. Call for 286/12



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-Personal Computing, Best Bargain Systems, Dec, 1989

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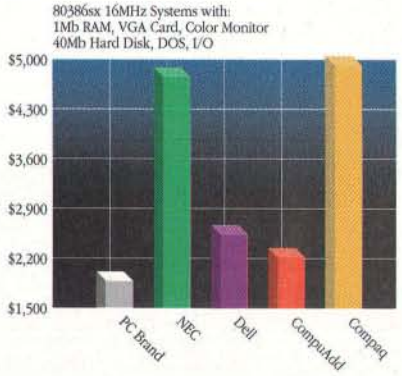
16 MHz Clock, Zero Wait Operation • Norton SI 18.7 Landmark™ 18.3MHz, 512K RAM, 1.2MB or 1.44MB Drive, 101-Keyboard, 2 Serial and 1 Parallel Ports

Standard System Features:

- 80386SX Processor Operating at 16MHz delivering 18MHz Effective Throughput
- 512K RAM expandable to 8MB on the System board using 256K and/or 1MB RAM
- 1.2MB 5.25" or 1.44MB 3.5" Diskette Drive
- FCC Class "A", Intended for business use
- High performance 16bit VGA Cards with optional 1024x768 capability
- 1:1 Interleaved Hard/Floppy Drive controllers, 1 Mb/Second disk transfer rates on all 100 Mb drives or larger
- Enhanced 101-key Click/Tactile Keyboard
- 2 Serial & 1Parallel ports on std-configurations
- High Capacity 200 Watt System Power Supply
- Real Time Clock/Calendar with 5 Year Battery
- 80387SX Co-Processor Support
- AMI BIOS with full MS/DOS, OS/2, XENIX, UNIX, NOVELL, 3COM compatibility
- 8 Slot motherboard design (5 16Bit & 3 8Bit)
- Medium foot print case w/ 6 Disk Drive bays (Shown in optional Mini Size Tower ® Case)

Options:

- Low profile Slim Line Case w/3 Disk bays
- Mini Size desk top Tower ® Case w/4 Disk Drive bays (as pictured above)
- VGA or CGA Plasma Portable Case
- Factory Installed RAM Upgrades
- Custom configurations w/Name Brand peripherals of your choice



PC BRAND 386SX-16

w/512k, Hard Disk Drive, Monitor & Video Card

Hard Drives: Mb/Ms	20/40	40/19	66/25	100/25
No Video	$1229	$1329	$1509	$1649
Mono	$1349	$1449	$1629	$1769
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-PC Magazine, 25MHz 386 PC's, Feb. 14, 1989

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2 Serial and 1 Parallel Ports

PC BRAND 386/25 ____ $1499

25 MHz Clock, Zero Wait Operation,
Norton SI 28.2-Landmark Speed 33.6MHz,
Norton SI 31.6-Landmark Speed 43.5 w/Cache,
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2 Serial and 1 Parallel Ports

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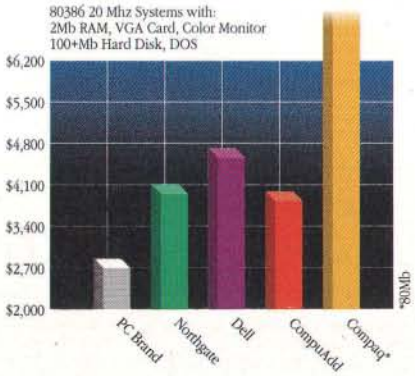
"and the company backs it all with what may be the longest warranty on the market...PC Brand makes it possible to buy two complete sytems for less than most competitors charge for just one."

- PC Magazine, 25MHz 386 PC's February 14, 1989



Standard System Features:

- True 20MHz or 25MHzZ Intel 80386 CPU Operating with Zero Wait States
- 1024K RAM standard expandable to 16MB using 256K and/or 1MB RAM
- 1.2MB 5.25" or 1.44MB 3.5" Diskette Drive
- FCC Class "A", Intended for business use
- High performance 16bit VGA Cards with optional 1024x768 capability
- 1:1 Interleaving Hard Drive/Floppy Drive controllers, 1Mb/Second disk transfer rates on all 100Mb drives or larger
- Enhanced 101-key Click/Tactile Keyboard
- 2 serial & 1 parallel ports on std-configurations
- High Capacity 200 Watt System Power Supply
- Real Time Clock/Calendar with 5 Year Battery
- 80287, 80387, or Weitek Co-Processor Support
- AMI BIOS with full MS/DOS, OS/2, XENIX, UNIX, NOVELL, 3COM compatibility
- 8 Slot motherboard design (5 16Bit & 3 8Bit)
- Medium foot print case w/6 Disk Drive bays

Options:

- Low profile Slim-Line Case w/3 Disk bays
- Full Size Tower ® Case w/8 Disk Drive bays
- Mini Size Tower ® Case w/4 Disk Drive bays
- VGA or CGA Plasma Portable Case
- Custom configurations w/Name Brand peripherals of your choice

(Shown in Medium foot print Desktop Case)

PC BRAND 386/20

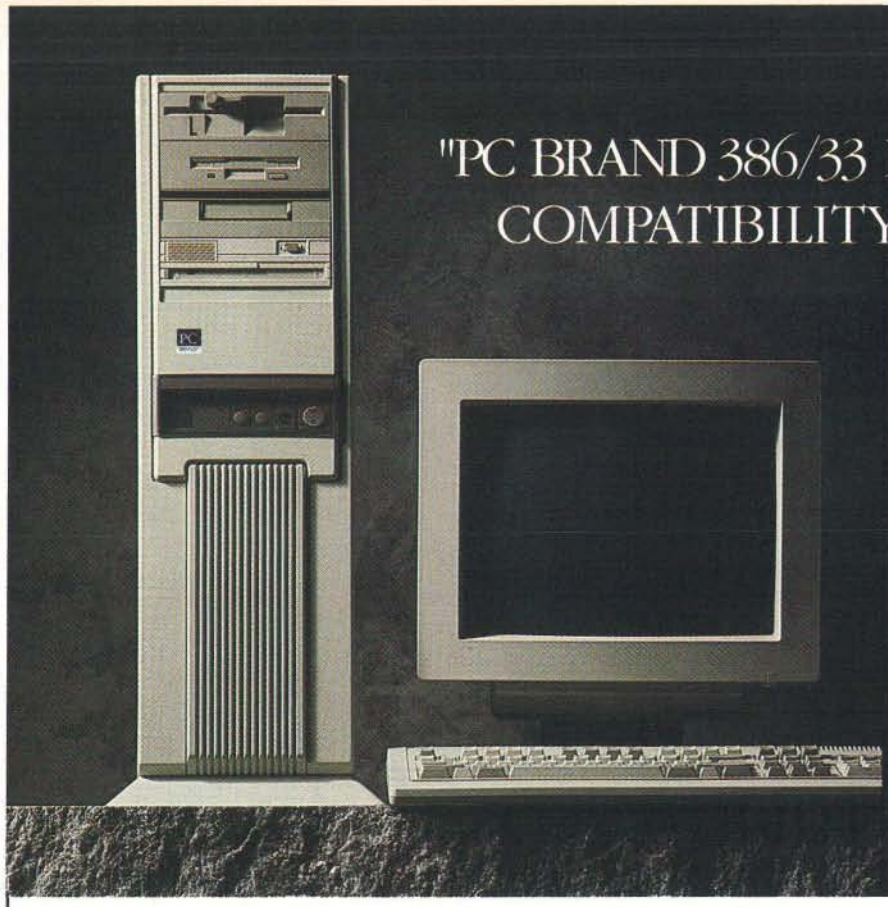
with Hard Disk Drive, Monitor & Video Card

Hard Drives: Mb/Ms	40/19	66/25	100/25	200/19
No Video	$1779	$1959	$2099	$2549
Mono	$1899	$2079	$2219	$2669
VGA-Mono	$2079	$2259	$2399	$2849
VGA-Color	$2309	$2489	$2629	$3079
SVGA/Color	$2419	$2599	$2739	$3189

PC BRAND 386/25

with Hard Disk Drive, Monitor & Video Card

Hard Drives: Mb/Ms	40/19	66/25	100/25	200/19
No Video	$1929	$2109	$2249	$2699
Mono	$2049	$2229	$2369	$2819
VGA-Mono	$2229	$2409	$2549	$2999
VGA-Color	$2459	$2639	$2779	$3229
SVGA/Color	$2569	$2749	$2889	$3339



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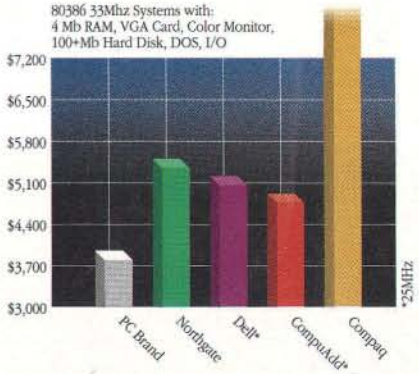
-Computer Buyers Guide, Product Review, February, 1990

Standard System Features:

- True 33 MHz INTEL 80386-33 CPU operating w/Zero Wait States Delivering up to 58.7 MHz Effective Throughput
- Intel 82385-33 Cache Processor with 32K 25NS Static RAM Standard
- 1024K RAM Standard Expandable to 16MB
- FCC Class "A", Intended for business use
- High performance 16bit VGA Cards with optional 1024x768 capability
- 1.2MB 5.25" or 1.44MB 3.5" Diskette Drive
- 1:1 Interleaving Hard Drive/Floppy Drive Controllers, 1 Mb/Second disk transfer rates on all 100Mb drives or larger
- Enhanced 101-key Click/Tactile Keyboard
- I/O Ports-2 serial,1 parallel
- High Capacity 200 Watt System Power Supply
- Real Time Clock/Calendar with 5 Year Battery
- 80387 or Weitek Co-Processor support
- Phoenix BIOS with Full MS/DOS, 0S/2, XENIX, UNIX, NOVELL, 3COM compatibility
- EMS and Disk Cache in ROM
- 8 Slot motherboard design
- Medium foot print case w/6 Disk Drive bays

Options:

- Full size Tower ® Case w/8 Disk Drive bays (as pictured above)
- Custom configurations w/Name Brand peripherals of your choice
- Factory Installed Ram Upgrades



PC BRAND 386/33 CACHE
with Hard Disk Drive, Monitor & Video Card

Hard Drives: Mb/Ms	40/19	66/25	100/25	200/19
No Video	$2679	$2859	$2999	$3449
Mono	$2799	$2979	$3119	$3569
VGA-Mono	$2979	$3159	$3299	$3749
VGA-Color	$3209	$3389	$3529	$3979
SVGA/Color	$3319	$3499	$3639	$4089

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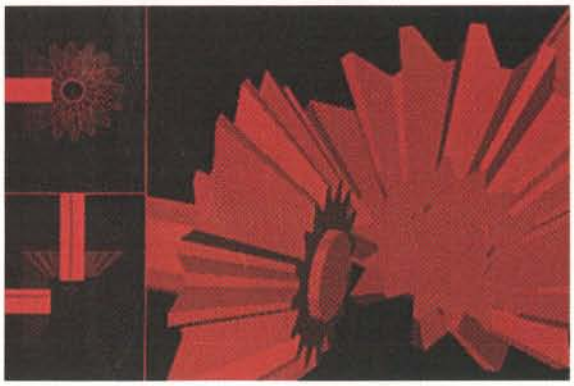

Actual VGA PLASMA Screen Image

Standard System Features:

- All performance and compatibility features as in desktops featured on previous pages
- 16 Grey Scale 640x480 VGA or 4 Grey Scale 640x400 CGA/Mono Graphics Plasma Display

Standard Features Continued:

- 3 Accessible Drive Bays for (2) 5.25" and (1) 3.5" Units
- 2 Available Peripheral Card Slots
- Simultaneous internal & external displays
- 200 Watt Auto Voltage Switching Power Supply

VGA Gas Plasma Portables

Drives Mb/Ms	1 Floppy	40/19	100/25	200/19
286/12	$2595	$2995	$3395	$3960
286/20	$2795	$3195	$3595	$4160
386/SX-16	$2895	$3295	$3695	$4260
386/20	$3350	$3750	$4150	$4710
386/25	$3550	$3950	$4350	$4910
386C/25*	$4000	$4400	$4800	$5360
386C/33*	$4300	$4700	$5100	$5600

*32K Cached

CGA/MGA Gas Plasma Portables

Drives Mb/Ms	1 Floppy	40/19	100/25	200/19
286/12	$1745	$2145	$2545	$3110
286/20	$1945	$2345	$2745	$3310
386/SX-16	$2045	$2445	$2845	$3410
386/20	$2495	$2895	$3295	$3855
386/25	$2695	$3095	$3495	$4055
386C/25*	$3145	$3545	$3945	$4505
386C/33*	$3445	$3845	$4245	$4805

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1304 14" SVGA (to 1024x768) $689
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VGA 1024 with 512K 239
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2400B Internal with Smartcom 249
1200 External ..... 285 2400 External 359

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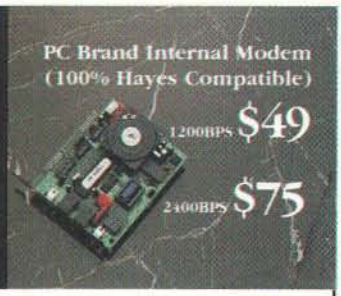

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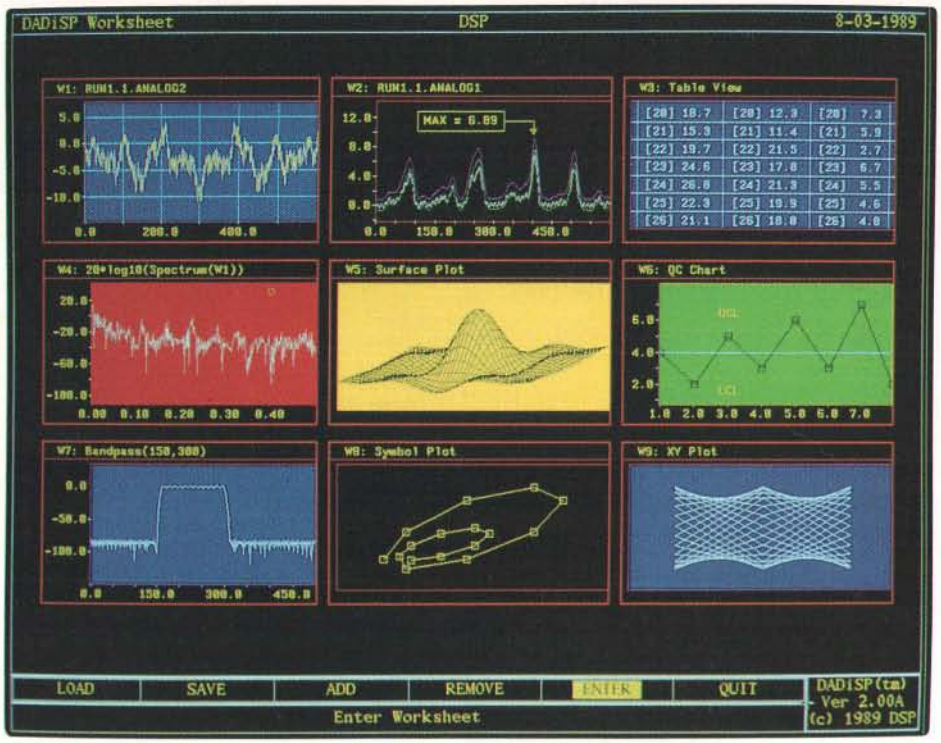

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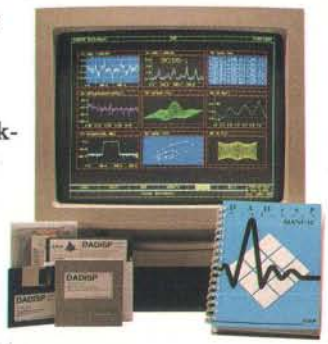

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CONSORTIA: HIGH-TECH CO-OPS

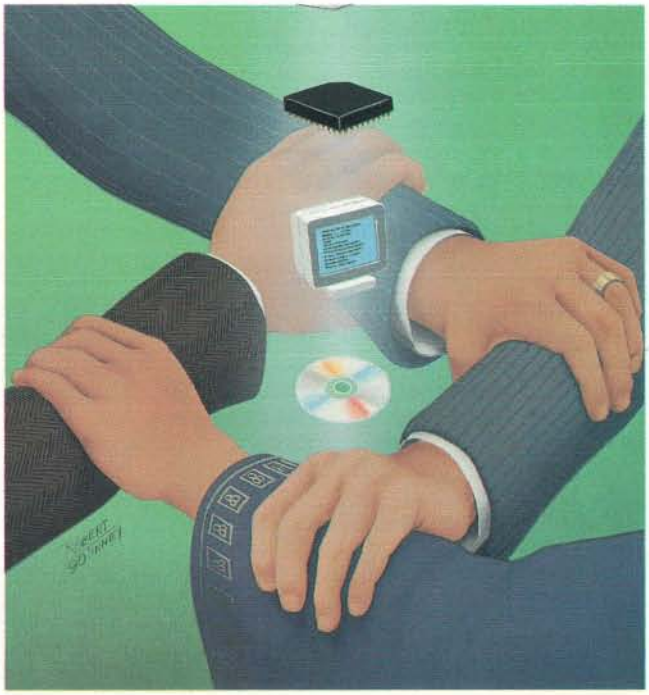
Computer consortia may help U.S. high-tech companies compete on a global level

Janet J. Barron

A proposed association of American semiconductor manufacturers called U.S. Memories was still in the formative stages when its director threw in the towel early this year. The ill-fated association was intended to help its members compete in the DRAM market. In the wake of U.S. Memories' demise, it seems appropriate to examine the concept of computer consortia: What are the driving forces behind these organizations? Which ones are working—if any? And what are the implications for America's ability to compete in the international marketplace?

Just what is a consortium? Generally, it is a joint R&D effort (most often nonprofit) between companies, universities, industries, and sometimes a state or national government. The main goal of a consortium is to help companies (and industries) maintain their leadership positions or gain an edge over their international competitors (see the table). The advantages of cooperative efforts between companies include transfers of technology and savings in labor power, time, and resources.

In the U.S., two principal forces drive the current tendency to create and develop U.S. high-technology consortia: the increasing strength of Japanese and European technological advances and America's need to avoid being dependent on outside suppliers for its computer devices and components. The stakes in this struggle are so high that many believe the basic survival of U.S. high technology is in jeopardy. Some believe the fight has already been won—and not by America.



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Learning from the East

Japan has been a pacesetter in creating heavily funded and strongly supported consortia and joint ventures. For some 65 years, Japan has used two main vehicles to drive its industrial/technological push: a governmental agency called the Ministry of International Trade Industry (MITI) and the Nippon Telephone and Telegraph (NTT).

MITI was founded in 1925, with a mandate to "protect and promote healthy development of Japanese industry, trade, and technology." Its purpose remains the same today, and Japan has backed this effort to the tune of billions and billions of yen.

Although neither NTT nor MITI is formally a consortium, MITI has spawned a number of consortia that have made tremendous technological advances: ICOT (Institute for New-Generation Computer Technology), created to study parallel processing; SORTEC (Synchotron Orbital Radiation Technologies),

continued

SOME INTERNATIONAL JOINT MICROELECTRONIC EFFORTS

The development of consortia in the U.S. is designed to offset intense international efforts to replace the U.S. as the world's technological leader and to assure it of a reliable source of computers and computer components. Shown here is a sampling of foreign government-supported microelectronic R&D programs.

Country	Project	Companies	Technical focus	Time frame	Government funds (millions of dollars)
Japan	MITI VLSI	5	VLSI manufacturing	1975-79	112
Japan	NTT VLSI	3	VLSI device	1975-79	309
Japan	New function elements	12	VLSI device and manufacturing	1981-90	140
Japan	Supercomputer	6	High-speed devices	1981-89	135
Japan	Optoelectronics	13	Optical semiconductors	1979-86	80
Japan	SORTEC	13	Synchrotron lithography	1986-96	62*
Japan	Optical ICs	13	Optical semiconductors	1986-96	42*
Korea	ETRI 4-MB DRAM	4	Develop 4-MB DRAM	N/A	80
EEC	Esprit	Many	Commercial computing	1984-94	675
Germany-Netherlands	Mega Project	2	1-MB static RAM/4-MB DRAM	1984-89	150

* Funding from Japan's Key Technology Center includes some private contributions.

devoted to working with x-ray lithography and generation methods; and the OTRC (Optoelectronics Technology Research Corp.), a 13-company venture that carries out optical IC R&D. The Japanese have been extraordinarily successful in their drive for industrial and technological superiority in the areas of chips, chip-making equipment, and other consumer and commercial electronic devices.

Cause and Effect...

In the late nineteenth century, the U.S. became heavily involved in its own industrial revolution. The turn of the century brought big-time progress in steel, railroads, oil, and other major enterprises. Entrepreneurs such as the Rockefellers, Carnegies, Mellons, and Morgans came into prominence as they created monopolies in these essential industries. With these monopolies came unfair economic and labor conditions. As a result, between the late 1800s and the mid-1900s, the U.S. government instituted a number of antitrust laws, the most famous of which were the Sherman and Clayton Antitrust Acts (1890 and 1914).

During the depression years, the U.S. made few industrial or technological advances. Then came World War II—destined to be the first war fought by scientific military tactics instead of sheer brute force. It quickly became apparent that the winner would be the country that could technologically outmaneuver its opponents. Thus, the U.S. began to make use of the consortium concept to play catch-up with its adversaries. Because of the stringent antitrust laws in place at the time, though, U.S. companies were extremely reluctant to take full advantage of this type of collaborative effort.

Japan's recovery from the war entailed major "damage-control" efforts. Along with the restoration of its economy, Japan also began to make significant technological strides. In the 1980s, Japan ramped up its efforts to create a fifth-generation computer. When the U.S. recognized the seriousness of the Japanese threat to its technology base, those in charge of administering antitrust laws became more willing to soften the rules a bit.

In 1982, the U.S. Department of Justice announced that it would not initiate an antitrust challenge to the formation of one of the first computer-oriented consortia, the Microelectronics and Computer Technology Corp. (MCC), based in Austin, Texas. And in 1984, the passage of the subsequent National Cooperative Research Act spurred approximately 70 consortia to file their intentions to form.

While most consortia are research-driven, some have other goals. Several, such as Unix International, Open Systems Interconnection (OSI), and Common Access Method (CAM), are devoted to creating and implementing standards for emerging technologies. In this article, I'll address only research-driven high-technology consortia.

Mandates and Projects

The firstborn computer consortium, MCC, conducts research in five main areas: advanced computing technology, CAD, high-temperature superconductivity, packaging/interconnects, and software technology and research commercialization. One MCC goal, to make computers easier to use, has led to a human-interface project called the Interactive Work Surface. When completed, this device will allow paper-and-pencil-like communication with a computer (see photo 1).

Another of MCC's active projects is an advanced technology used in chip fabrication called laser bonding. This is a maskless laser direct-write technology that enables much easier, faster, and less expensive customization of prototype chip designs.

One outgrowth of MCC was the founding of SEMATECH (Semiconductor Manufacturing Technology Initiative), an industry/government consortium with 14 semiconductor producers and the Defense Advanced Research Projects Agency (DARPA). SEMATECH's aim is to develop advanced manufacturing technology that will enable the U.S. to be competitive worldwide and to provide a domestic source of chips.

SEMATECH currently has 54 projects under way, involving R&D in areas such as lithography, strategic materials, multilevel metals, and furnaces (see photo 2). SEMATECH has also, in collaboration with the Semiconductor Research Corp. (SRC), established a Centers of Excellence program, which selects outstanding universities and works with them to attract and maintain top-notch faculty and provide graduate students

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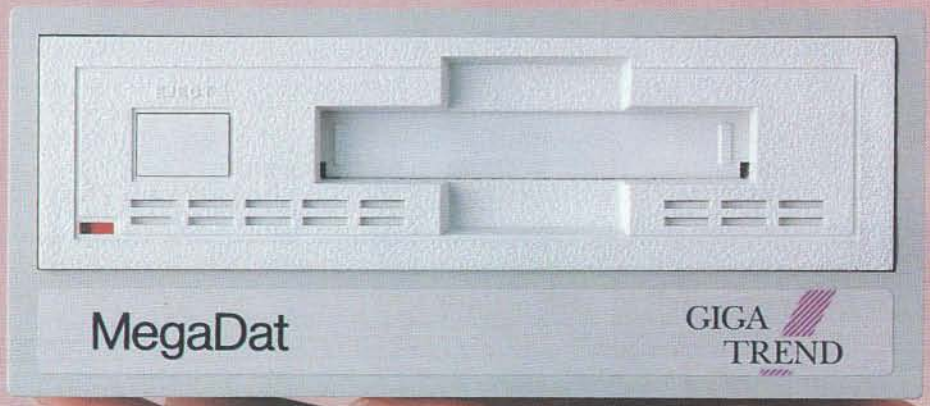

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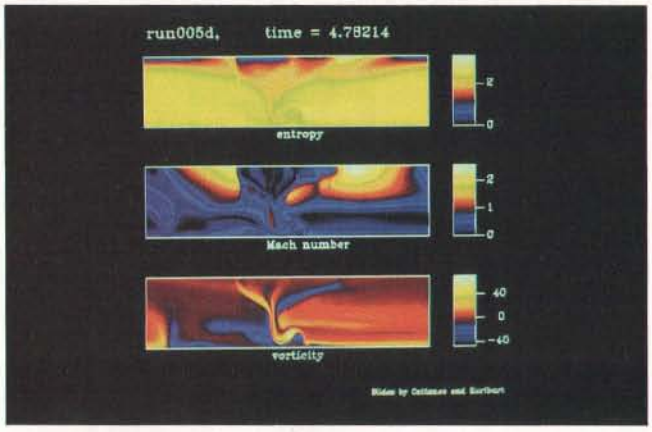

Photo 1: *As part of one of its current human-interface projects, the MCC is developing an Interactive Work Surface, a device that will allow paper-and-pencil-like communication with a computer.*

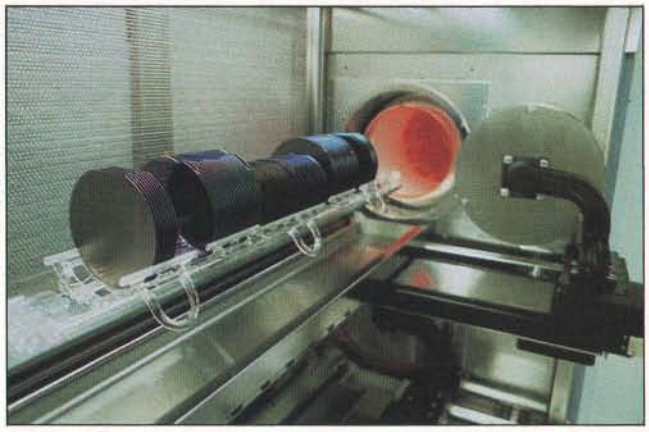

Photo 2: *Research at the Austin, Texas, semiconductor consortium, SEMATECH, centers around ways to efficiently fabricate chips. Here, wafers are being prepared for loading into a furnace chamber.*

Photo 3: *This visualization is a part of ongoing research into stellar convection, conducted by Cattaneo, Hurlburt, and Toomre at the John von Neumann Center for Scientific Computing. Here is an idealized model of thermal supersonic convection within a star.*

with superior technological knowledge and experience.

The SRC was created to plan and implement an integrated program of basic research conducted by faculty and graduate students at leading U.S. universities. This research is related to a set of long-range industry goals that reflect the need for improved performance and higher-density ICs.

The Massachusetts Microelectronics Center (M^2C) is a consortium created by the Commonwealth of Massachusetts in partnership with industry and the state's engineering colleges and universities. It is dedicated to improving the quality of engineering education for students intending to design ICs. M^2C's 10 member universities have shared access to the center's facilities in Westborough, Massachusetts, which include a state-of-the-art CAD center and an IC fabrication facility for the production of student-designed chips. Staff members supply ongoing training and technical support for university researchers and educators as well. M^2C was chosen to be one of SEMATECH's Centers of Excellence.

The Consortium for Scientific Computing in Princeton, New Jersey, is composed of 13 major universities and institutions. These entities subsequently established the John von Neumann Center for Scientific Computing (JVNC) at the same location. The CSC is responsible for the overall management of the JVNC, serving 1500 users of the center nationally across a wide range of disciplines. The CSC is funded by the National Science Foundation (the consortium's founder), the state of New Jersey, and industrial participants of the consortium.

The JVNC is dedicated to making the latest and most powerful supercomputers accessible to users in academic, scientific, and industrial communities. Thus, users can conduct compute-intensive research projects not possible on smaller systems (see photo 3). At any university, personal computer and workstation users can connect to a regional network and from there to the host supercomputer. The connection to the national supercomputer network is then transparent to any of the host computers on the network.

At least two optoelectronic consortia now exist, with a couple more in the planning stages. The Center for Optical Manufacturing, based at the University of Rochester, was founded in 1989. COM's mission is not to manufacture optical devices, but to support the development of new optical manufacturing technologies. These include precision glass moldings, optical interconnects and packaging, and gradient index lenses. COM is a function of academia, the government, and the optical industry through the American Precision Optics Manufacturing Association.

Another active optoelectronic consortium, composed of a state government, local computer companies, and DARPA, is the Oregon Advanced Computing Institute, incorporated in 1988 and based in Portland. OACIS is dedicated to the development of advanced computing technology through applied research—mainly in the area of parallel-processing technology. One of OACIS's projects is the development of a prototype parallel-programming support environment. Such an environment

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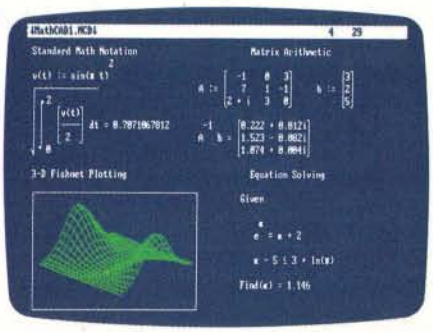

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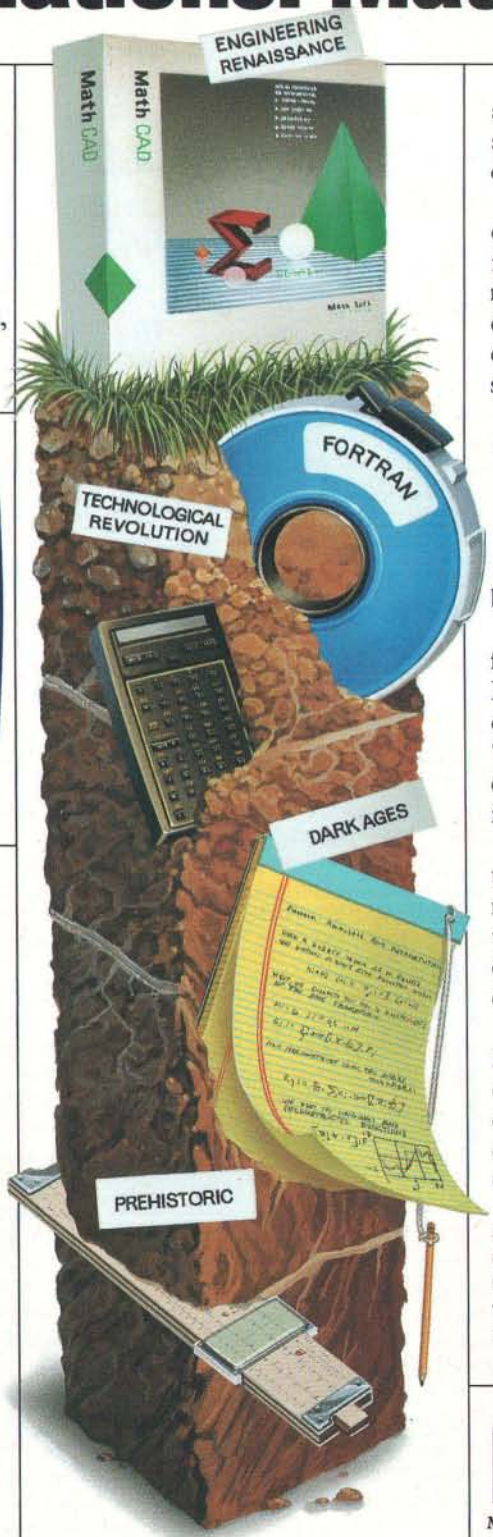

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On the Drawing Board

Building a consortium from the ground up isn't easy, as Sandy Kane, the head of the late U.S. Memories, found out. Nevertheless, at least a handful of major consortia are on the drawing board or in various stages of creation.

Under the auspices of the American Electronics Association, about 20 companies have signed up to become founding members of a consortium devoted to researching, developing, and perhaps even manufacturing high-definition TV. This joint effort is now being dubbed the Advanced Television Research Consortium.

Scientists at the Sarnoff Research Center in Princeton, New Jersey, have proposed a consortium to advance the state of LCD technology. Names of potential group members have not yet been made public.

Two new optoelectronic groups are also making plans to form consortia—one under the auspices of the Sarnoff Center and the other under the aegis of the University of Southern California's School of Engineering. The proposed Sarnoff-sponsored effort, tentatively called the Optoelectronic Integrated Circuit consortium (OEIC), is having a tough time obtaining commitments from companies to join and support the venture. Founders of the OEIC hope to create a consortium that will build a fabrication facility to produce optoelectronic ICs in volume by 1996. But, says Carmen Catanese, proposed director of the facility, "Computer firms aren't buying into being part of a chip company in the manner we hoped they would."

The National Center for Integrated Photonic Technology is a group to be headquartered at the University of Southern California's School of Engineering. It consists of five universities: USC, Columbia, Kent State, MIT, and UCLA. NCIPT seems to be well on its way to reality. In January, DARPA granted an initial $12.5 million to the Los Angeles–based center.

The NCIPT's mandate will be to increase the level of integration currently possible with photonic devices and significantly advance the state of the art in integrating optical and electronic devices on a single chip. Its projects will focus on high-bandwidth and high-functionality devices and systems.

Another collaborative effort in the planning stages is a proposed consortium designed to carry out R&D in superconductivity. This group has the support of major corporate and academic forces such as IBM, AT&T, and MIT. If established, this consortium will concentrate on several areas: advanced devices and ICs, signal distribution and conditioning networks, high-temperature materials and technology, and superconducting quantum interference devices.

One potential hybrid consortium is worthy of brief mention here. In Europe, the Joint European Sub-micron Silicon Initiative (JESSI) was founded to advance the continent's progress in chip technology through a collaborative six-country venture. JESSI and the U.S.'s SEMATECH consortia are in the talking stages regarding forming an alliance. The mission of this so-called "superconsortium" would be to use the combination of their efforts in a synergistic manner to take on Japan in the chip race.

A Mixed Bag

Today's consortia are groups that comprise technology companies, industries, universities, the public and private sectors, the private sector alone, and various combinations of these entities.

MCC, for instance, is a computer research consortium composed of U.S. (and, potentially, Canadian) company "shareholders." One of MCC's shareholders is BellCore, the research arm of the Bell companies. BellCore itself has been called an "internal" consortium—that is, an R&D conglomerate that works for several different clients. Both MCC and SEMATECH are members of Semiconductor Research, which is a full-blown consortium in its own right located in Triangle Park, North Carolina.

Most consortia are created as not-for-profit entities, but some, such as MCC, are for-profit enterprises. Not only is MCC considering spinning off start-ups funded by venture capital, it also encourages researchers to leave the lab and participate in translating their experience into products.

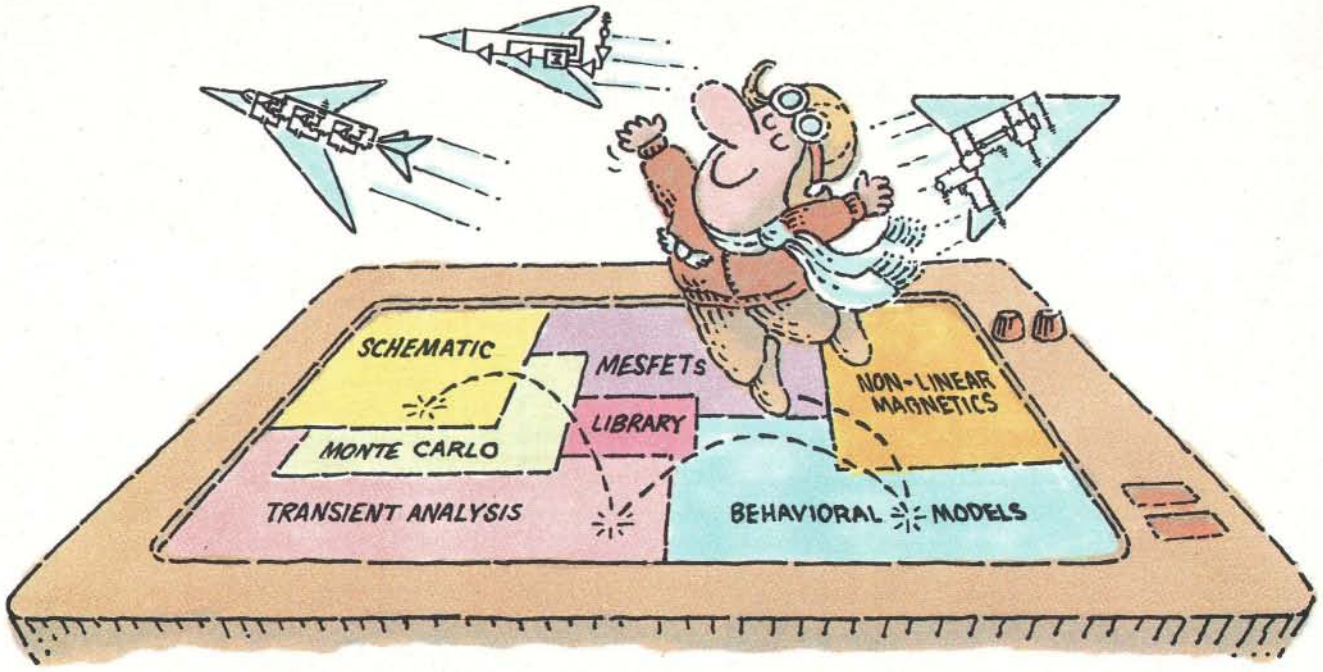
Funding and Fees

A complete discussion of the types of funding and member fees for the various technology consortia is beyond the scope of this article. The subject of funding alone is extremely controversial, and neither consortia proponents nor opponents can agree on whether U.S. tax dollars should go to these R&D collaborations. Of course, this diversity of opinion should come as no surprise, since there is no consensus on whether consortia should be allowed to exist at all.

R&D consortia usually calculate member or shareholder fees as a percentage of each of the affiliated organizations' income or sales. Many member fees start in the $25,000 range. SEMATECH, however, has a minimum of about $1 million and a maximum of about $15 million annually.

Other consortia are funded directly from the budgets of the state and federal governments, participating universities, and various grants that come their way. To allow smaller companies to be a part of the action, some of the larger consortia, such as SEMATECH, have created "affiliate" programs. These mini-memberships enable companies with budgets smaller than those of goliaths such as IBM, AT&T, and Intel to participate in

continued



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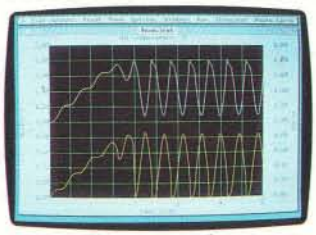

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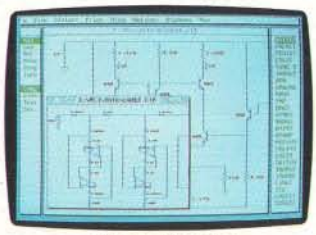

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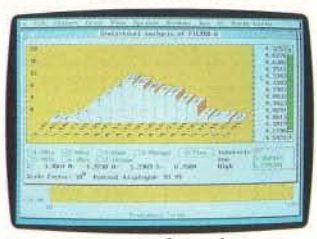

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Some industry representatives believe that creating consortia, composed mostly of large, deep-pocket companies, is enormously unfair to smaller companies and start-ups. Obviously, says this camp of believers, most firms don't have the big bucks necessary to join, participate in, and benefit from these usually prohibitively expensive organizations.

Robert Noyce, co-inventor of the IC and head of SEMATECH, disagrees with this premise. According to Noyce, the benefits of consortia-provided training for academics spills over to companies, large and small. Cross-fertilization and technology transfer help everyone, he says.

Consortia like SEMATECH perform very expensive research, notes Noyce. He adds that, by pooling resources, groups of companies can do some things individual companies cannot because of the costs and risks involved. "Consortia are restocking the stream. The benefits of consortia flow to start-ups just as they flow to other companies," Noyce says.

There are numerous theories as to why U.S. Memories failed to make the grade. The most prevalent assumption is based on the fact that although big-gun computer companies such as Digital, IBM, Intel, AMD, National Semiconductor, and Hewlett-Packard agreed to support the cooperative venture, others such as Sun and Apple declined to get behind the effort.

Also, U.S. companies, many with near-term profit goals in mind, stopped short of committing funds and support to the organization. And with the recent infusion of previously unavailable chips, several companies decided to trust to luck for future supplies. Bad timing was the major factor in the demise of the proposed consortium, say industry spokespeople.

Strange Bedfellows

The confusion surrounding these issues has led to some unusual liaisons between U.S. and foreign companies and consortia: IBM and West Germany's Siemens; IBM and JESSI; and Intel and NMB Semiconductor.

The first part of this year saw IBM ink an agreement with Siemens to codevelop 64-megabit DRAMs. The prohibitive costs (now running into hundreds of millions of dollars) involved in the process of producing high-density memory chips was given as the reason for the joint venture.

The potential JESSI/IBM collaboration proposes to undertake certain projects essential to the establishment of leading European and U.S. supply industries. Since IBM is a major figure in SEMATECH, the proposed liaison could lead to SEMATECH's inviting JESSI to join its ranks. Currently, SEMATECH does not allow foreign companies or organizations as members.

The partnership that caught many industry pundits by surprise is that of Intel and Japan's NMB. The goal of this joint venture is to manufacture and market high-speed DRAM chips. The new company, Intel/NMBS DRAM Fabrication Co., is planning a factory in Japan to manufacture 1-megabyte and 4-MB DRAMs starting in the mid-1990s, to be followed by a U.S.-based DRAM-manufacturing site. Since that announcement, several other joint U.S./Japanese collaborations have been announced.

The U.S. is forming consortia to try to neutralize Japan's threat to monopolize, dominate, and control the supply and prices of much of its essential technology. Given that, the affiliation of domestic and Japanese companies has indeed created very strange bedfellows. ■

Janet J. Barron is a technical editor for BYTE. She can be reached on BIX as "neural."

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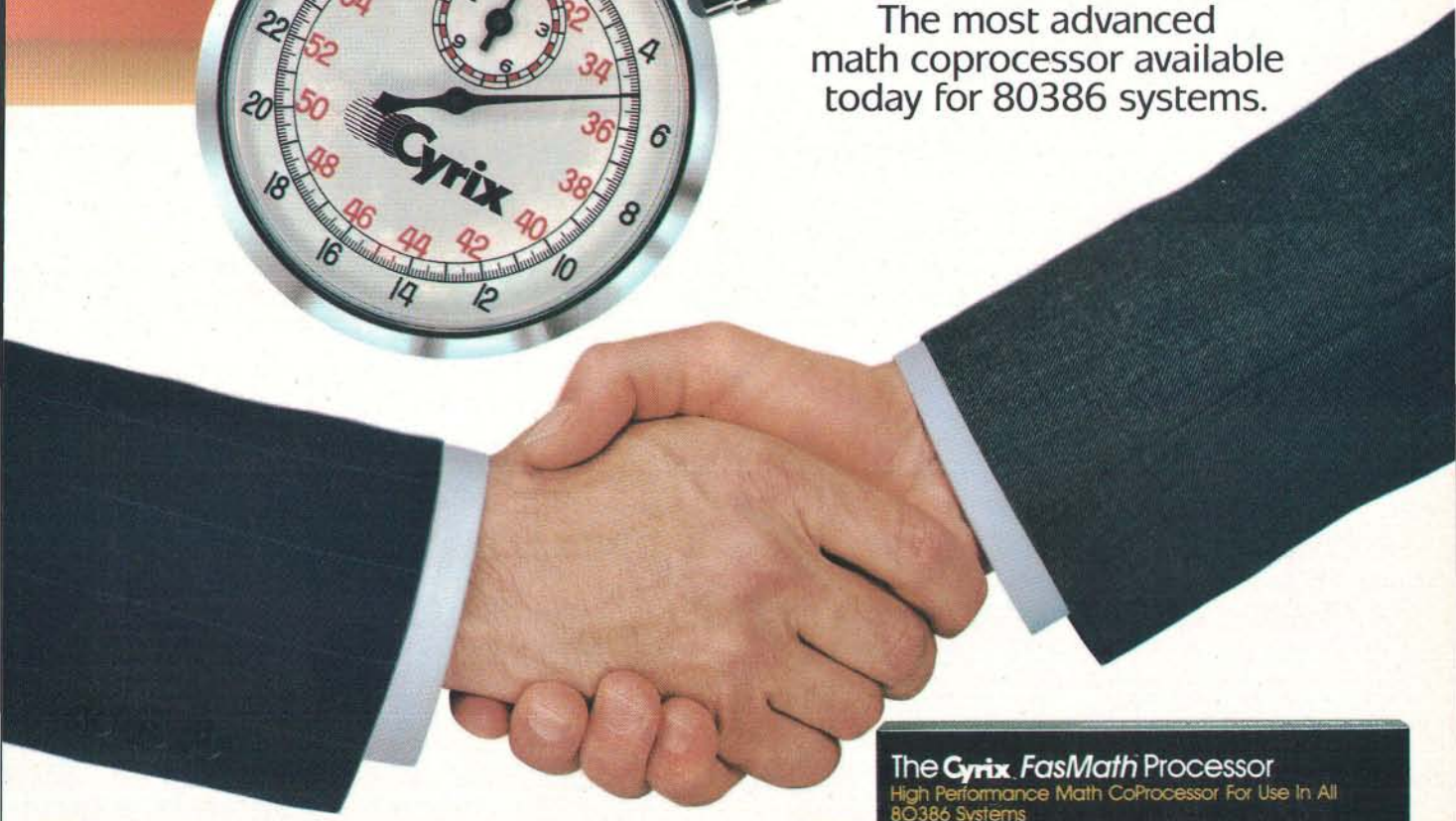

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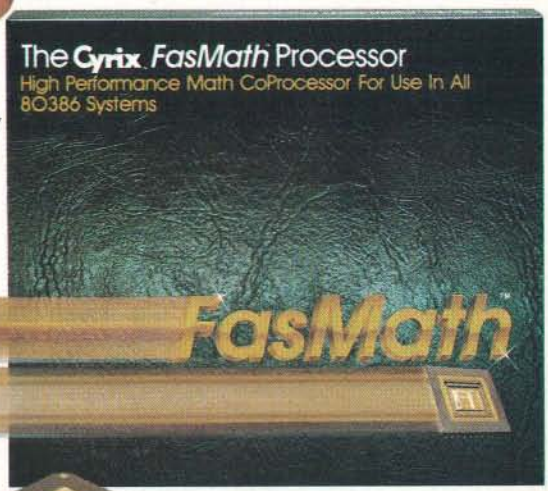

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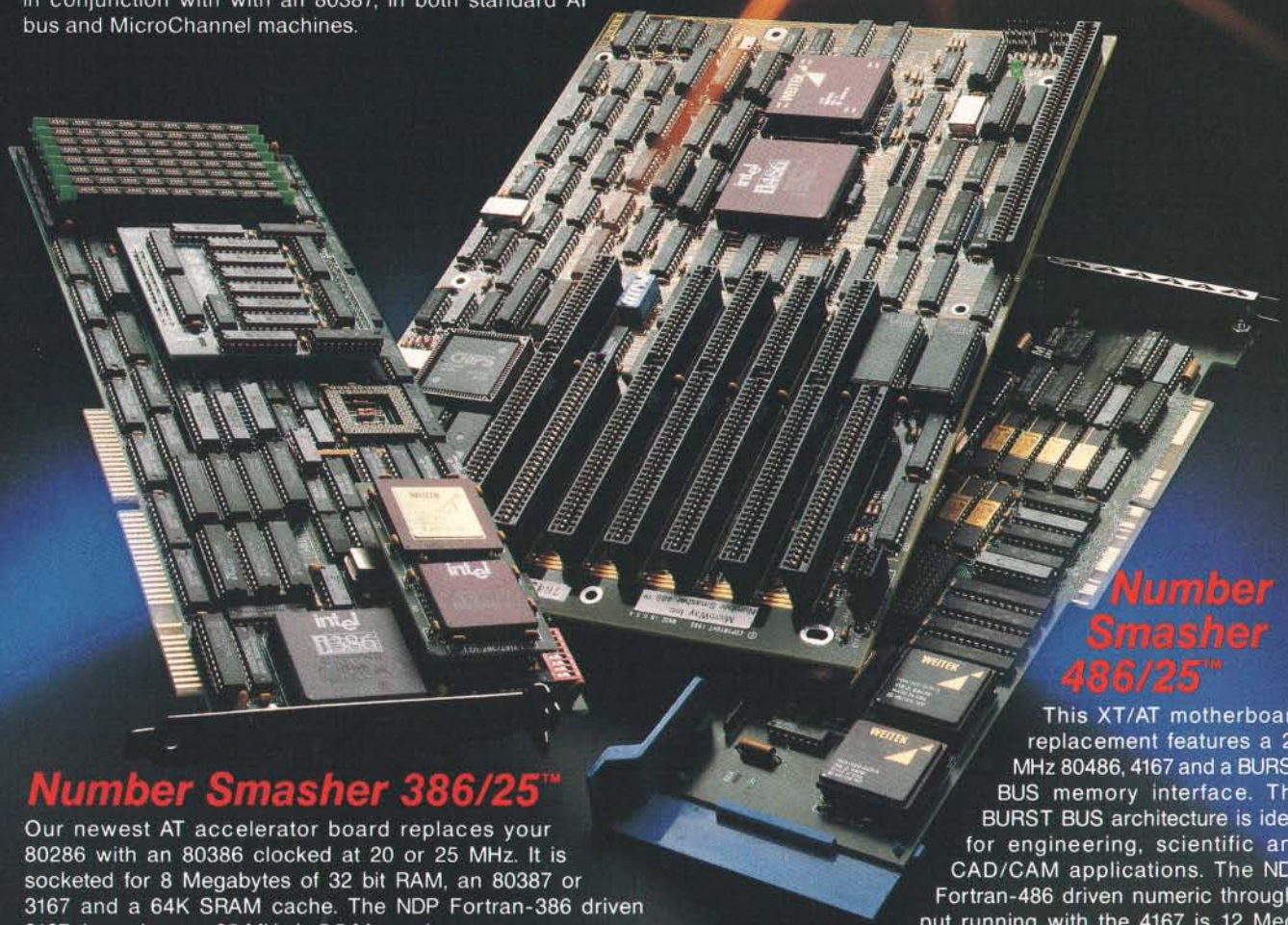

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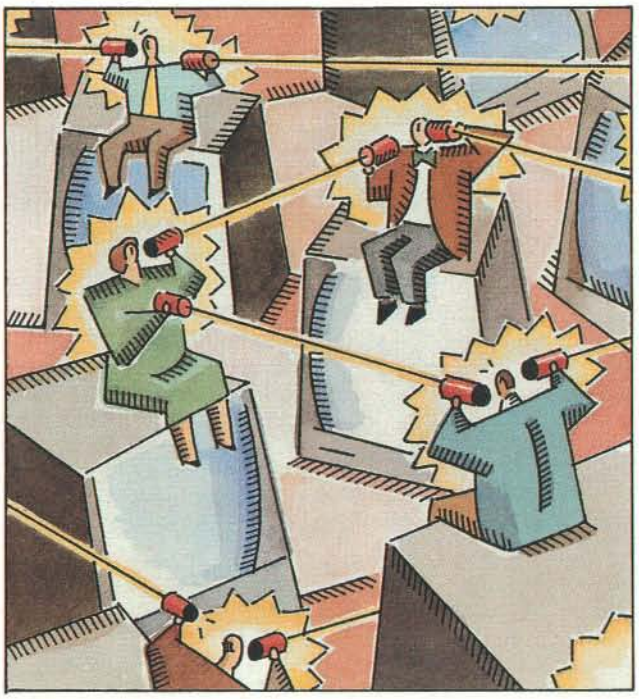
DOS AND UNIX: ON SPEAKING TERMS

What could DOS and Unix possibly have to discuss? Plenty.

Tom Yager

Corporate computing isn't what it used to be. Time was, there were one or two mainframes on the raised floor. Only those users with the most obvious need had terminals. Now, many companies suffer with a mishmash of these mammoth beasts, minicomputers, and, of course, workstations and personal computers. Methods for getting the microcomputers to talk to the mainframes have long been known, and making these connections is a big business, since nobody *willingly* wastes an investment in the heavy metal. But still, many managers have missed seeing a great improvement to their return on investment in Unix hardware: hooking PCs into an existing Unix network.



Why Bother?

For some, the advantages of a high-speed connection between any two computers are obvious. Oddly, many still resort to sluggish serial connections, schlepping data around at speeds as slow as 9600 bps. Granted, there are excellent software packages that make the most of this primitive link, providing file transfer and other network-like services, but when it comes to Unix, there's simply no substitute for the real thing: Ethernet.

Ages ago, a silent consensus was reached among Unix vendors that Ethernet was the way to go, and that has vastly simplified intermachine connections ever since. As a result, Unix users have been spoiled by rapid mail delivery, remote terminal services with multiple sessions, and file and resource sharing network-wide. To top it off, Unix networks are ridiculously easy to use once they're set up.

The PC: It's Not Just for SideKick Anymore

All this raging connectivity has found its way to the desktop with the graphics workstation boom, but the lowly PC has a deserving role in this pact, as well.

It would be easier if you could think of PC-to-Unix connections in terms of PC-based LANs, but Unix does things differently. The most typical PC LAN is one governed by a central system, the *server*, to which all the disk drives, printers, and other shared resources are connected. These server-based LANs work well, but they allow only limited access from one desktop to another, and such traffic must first pass through the server. A concept closer to that of Unix is the PC *peer-to-peer* LAN, where each system in the network is capable of communicating with all the other systems directly, and without the wastefulness of dedicating a single machine to the provision of services. Disk drives, printers, and other sharable

continued

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Since Ethernet is the Unix network rule of law, to connect to the Unix network, you must teach your PC to abide by the statute.

resources, regardless of their location, can be tapped by other network members. Most of these PC LANs are incapable of sharing one of the most costly resources, compute power.

A Unix network connection supplies all the services discussed above, and then some. The network wire can be used to set up a virtual terminal connection (through `rlogin` or `telnet`), which is fully interactive and (usually) very fast. Files can be electively copied back and forth, using either a variant of a simple copy command (called `rcp`) or a client/server application, `ftp`, which creates a specialized session during which a user can browse through the directories on someone else's machine and send and receive selected groups of files.

An individual command can be remotely executed on someone else's system (using `rsh` or `rexec`), passing its results to the user's display or logging them in a file. Finally, specialized client/server applications can connect across the network to converse on any number of topics, from graphical windowed environments (the X Window System [referred to as X Window hereafter]) to E-mail (Simple Mail Transfer Protocol—SMTP).

If some of the terms in the preceding paragraph were unfamiliar, don't be concerned. Every one of the oddly named services described above can be accessed from a PC, and the rest of this text will show that it's not as hard as you might think.

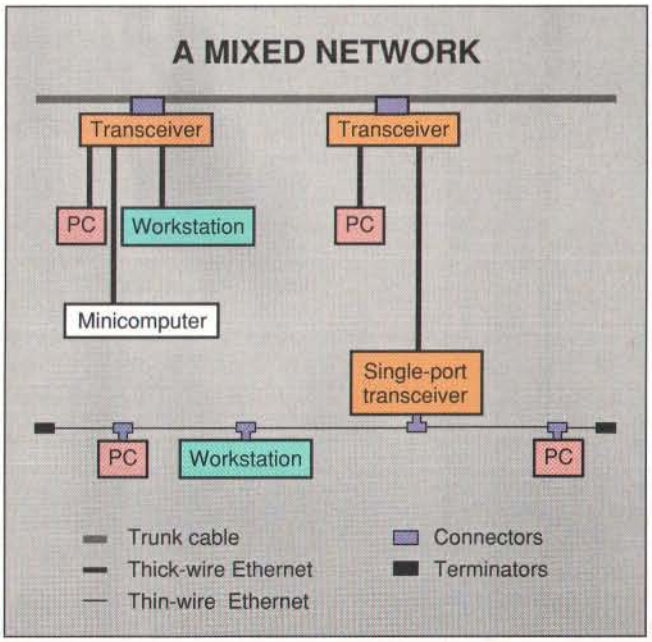

Figure 1: *Through the use of a thick-wire/thin-wire single-port transceiver, machines using both thin-wire and thick-wire Ethernet can all communicate.*

What's Life Without Cable?

If you're like many PC users, you've already got a cable jutting out the back of your computer, trailing under floor or over ceiling to your hallowed server. As I am a certified Unix snob, you might expect that my first instruction would be to sever your ties to the dark DOS ages. Quite the contrary: A Unix connection is no replacement for the services of a good DOS LAN.

Since Ethernet is the Unix network rule of law, to connect to the Unix network, you must teach your PC to abide by the statute. There are dozens of network cards out there, with varying degrees of functionality and price, and selecting one is your first step toward making the connection.

Smart or Dumb, Thick or Thin?

There are two basic classes of cards: smart and dumb. The dumb card simply passes data through to the host, sapping some CPU resources in deciphering raw network packets. Smart cards process the protocol on the card, maintaining intermachine connections and watching over the network with reduced CPU intervention. While it would appear that the smart cards have the advantage, reports of the actual degree of improvement vary. There are some tasks at which faster processors excel, and moving blocks of data to and from I/O boards is among them. If performance is that important, get specifications from a few manufacturers before making your decision.

Smart card or dumb, there are presently two accepted ways to carry Ethernet: thin wire and thick wire. (A third choice, unshielded twisted-pair, is still in the standards development stage and therefore not consistently implemented.) Thin wire is cheaper than thick, the cables are easier to make or buy, and connections are as simple as those for cable TV.

Thick wire is aptly named for the fat, multiconductor cable that carries the signal. Its use is further complicated by the requirement of an external device called a *transceiver*, which amplifies and passes signals between machines and among other transceivers. Thick Ethernet is something of an anachronism, bulky and inconvenient, and it doesn't blend well with the turnkey environment of PCs. But since it can bridge longer distances, it is the backbone of many existing Unix networks. A compact, single-port transceiver costs about $200 and is enough to get a roomful of machines connected to a thick-wire network through the more convenient coaxial cable. Making native connections to a thick-wire network involves placing a transceiver nearby. Each such unit typically fans out to eight or more sockets, into which are plugged the thick cables that are dropped to the workstations. Transceivers are connected together via a trunk cable or thin Ethernet wire. (See figure 1.)

With thin wire, it's pretty much plug-and-play. Each machine is attached to the network through a three-way (or "T") connector. One side goes into the host's network adapter, and the other two pass the signal through to systems up and down the line. Each system is connected to the network serially, like tying periodic knots in a single length of rope, and the last machine on either end of the "rope" must have the unused side of its T connector terminated with a special resistor.

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amiga.hw	Amiga hardware design, use, and hookup
amiga.arts	Artistry using the Amiga
amiga.int	Developing for the international Amiga
amiga.special	Special guests and events
amiga	BIX Archive: The original Commodore Amiga conference
amiga.update	Commodore's private conference for certified developers
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amiga.dev	Commodore's conference for developers

IBM Exchange

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ibm.at	The AT series and workalikes
ibm.ps	The PS/2 series
ibm.os2	OS/2 operating system
ibm.dos	PC/DOS & MS/DOS operating systems
ibm.os.386	Alternative 386 operating systems
ibm.utils	Utility software for IBM computers
ibm.repairshop	Garage and Tune-up Shop
ibm.new.prods	New products for IBM computers
ibm.exchange	IBM Exchange clearinghouse
ibm.listings	An index to all Listings files in the IBM Exchange
ibm.other	Applications, printers, modems, etc.
microsoft	Products from Microsoft

Mac Exchange

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mac.desktop	Publishing with a Mac
mac.external	Information from all over
mac.hack	Technical information about all aspects of the Mac
mac.macappda	Macintosh Applications Developer's Association
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word.processor	Word-processing programs
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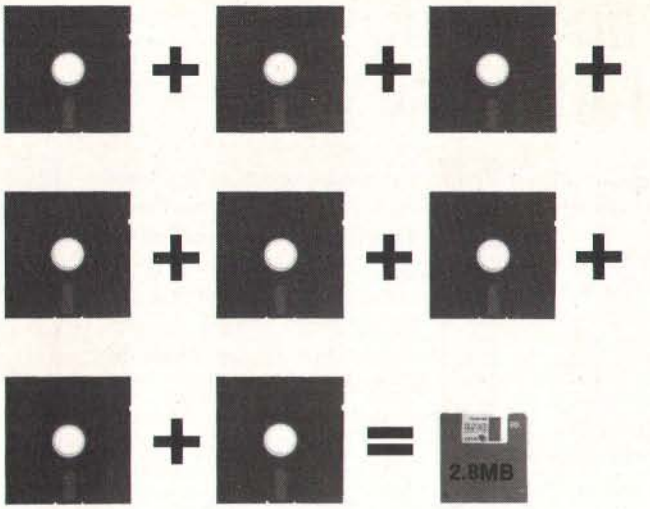

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A Node by Any Other Name

Without software, even the most brilliantly designed network is only a highway for electrons. TCP/IP (Transmission Control Protocol/Internet Protocol), whether resident on a smart card or running on the host's CPU, does all the work. Every system on a network receives all the packets zipping across the wire. It's TCP/IP's job to decide which ones to ignore and how to deliver the ones it pays attention to. Every packet carries with it the identification of the sender and the intended recipient. Packets are filtered such that only those destined for the current host, and special "broadcast" packets, are retained.

Each network member, or *node*, must be uniquely identified by a numeric *internet address*. A `hosts` file contains a simple translation between the numeric addresses and character-based names. In this file, each 4-byte address is usually expressed as four dot-separated numbers. Depending on how the address is constructed, 1, 2, or 3 bytes can be devoted to a node's individual ID. The remaining bytes identify the network on which the node resides. Most installations have less than 255 nodes connected to a single network, so a sensible addressing scheme reserves 1 byte for the node ID, and the remaining 3 identify the network. For example, an address of 192.1.1.17 identifies node 17 on network 192.1.1 (see figure 2). A first byte in the range of 0–127, 128–191, and 192–223 allows for host addresses of 3 bytes, 2 bytes, and 1 byte, respectively. It's also possible to reserve a number of bits in the host address to identify a *subnet*, or branch off the main network. These schemes let the designer adapt the address to the size of the network or the number of individual networks.

Connecting networks is also part of TCP/IP. To join two networks, you must connect one node, through separate network adapters, to both of the networks to be joined. Once you configure TCP/IP to recognize the node as a gateway, every node on any of the joined networks can transparently communicate with all the other nodes. A gateway simply shunts packets destined for another network through the appropriate adapter. In this manner, any number of networks can be joined together; TCP/IP is smart enough to route packets through several gateways in sequence as needed. Several companies offer self-contained gateways, but a good application for outdated PC equipment is as a dedicated router.

continued

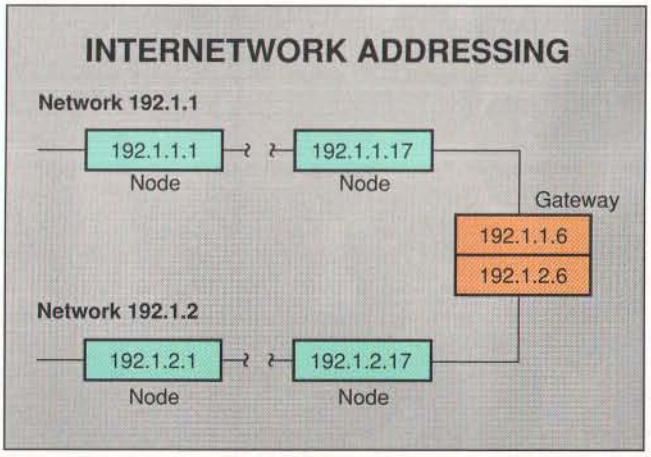

Figure 2: *This example of internetwork addressing shows two networks (denoted by 192.1.1 and 192.1.2), each of which has 17 nodes. The networks are linked by a shared node (or gateway) that has addresses on both networks.*

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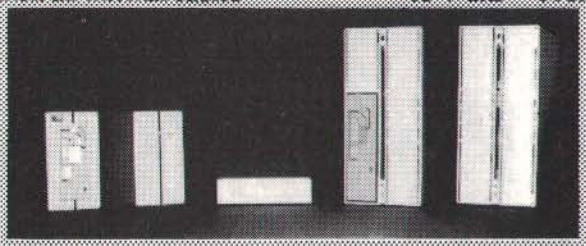

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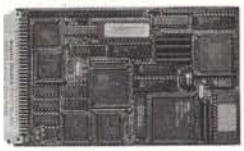

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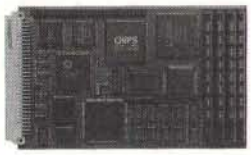

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Poor Little DOS Box

On Unix, TCP/IP is managed by a combination of device drivers, background processes, and user applications that create, maintain, and monitor network connections. They also make file sharing, E-mail delivery, and other services available to other systems on the network. Because Unix is a multitasking operating system, it's possible to have multiple services available to other nodes simultaneously.

MS-DOS is capable of partaking of the fruits of a Unix network, but with limitations (related to its memory and tasking deficiencies). Specifically, TCP/IP software must fit in a memory space small enough to leave room for traditional DOS applications to run. DOS's lack of multitasking makes a DOS machine more a consumer than a provider of services.

One widely used TCP/IP package for DOS comes from FTP Software. Through a mix of device drivers and a TSR networking kernel, FTP's PC/TCP provides all the services familiar to Unix users. To hook up, you bind the hardware characteristics of the network card into the PC/TCP kernel and drivers, along with the internet address and other operating parameters. You also need to fill a `hosts` file with the addresses and names of those nodes on the network that the PC needs to reach.

You also must supply a Unix user name. Any attempt to execute a command on a remote Unix host must be accompanied by a user ID that is valid on the Unix host.

Once a configured PC/TCP kernel is running, the PC becomes part of the network. PC/TCP's `ping` utility is the quickest test of a successful network connection. It ricochets a network packet off a selected host on the network and waits for a response. If `ping` reports that the host or network is unreachable, cabling, hardware, and software configurations should be checked until the problem is found.

Cranking Up the Engine

Getting there is not half the fun; it's the most difficult part of dealing with TCP/IP. Once running, the file transfer and remote-execution services mentioned above are very easy to use, but they are still only the beginning. While DOS and OS/2 network mavens are getting all lathered up over the advent of client/server applications, Unix has been doing it for years.

Being a single-tasking operating system, DOS makes a better client than server. If you know what single service you want from the PC and are willing to dedicate the PC to providing it, it is possible to use a DOS machine as a limited network server. The `ftpsrv` command in PC/TCP, for example, lets other (multiple) hosts attach to the PC and transfer files using `ftp`. Similarly, `smtpsrv` places the PC on alert for incoming E-mail using SMTP. These servers usurp the entire system until you ask them to quit, so they are best for overnight or for other unattended use. They do provide the full set of SMTP and `ftp` services. Your Unix users will have no idea that they are connecting to a DOS system.

Share and Share Alike

With all this networking, there would seem to be one service that has been neglected: file sharing. PC/TCP provides this service in InterDrive, a package that connects to a server offering connections to Sun Microsystems' Network File System. NFS expands the usefulness of a network by making the disk resources of remote machines appear as local devices to workstations and PCs.

NFS is somewhat slow, partly because it is *stateless*; even if a server crashes, reboots, and reinitializes everything, a client's session can pick up exactly where it left off. To accomplish this,

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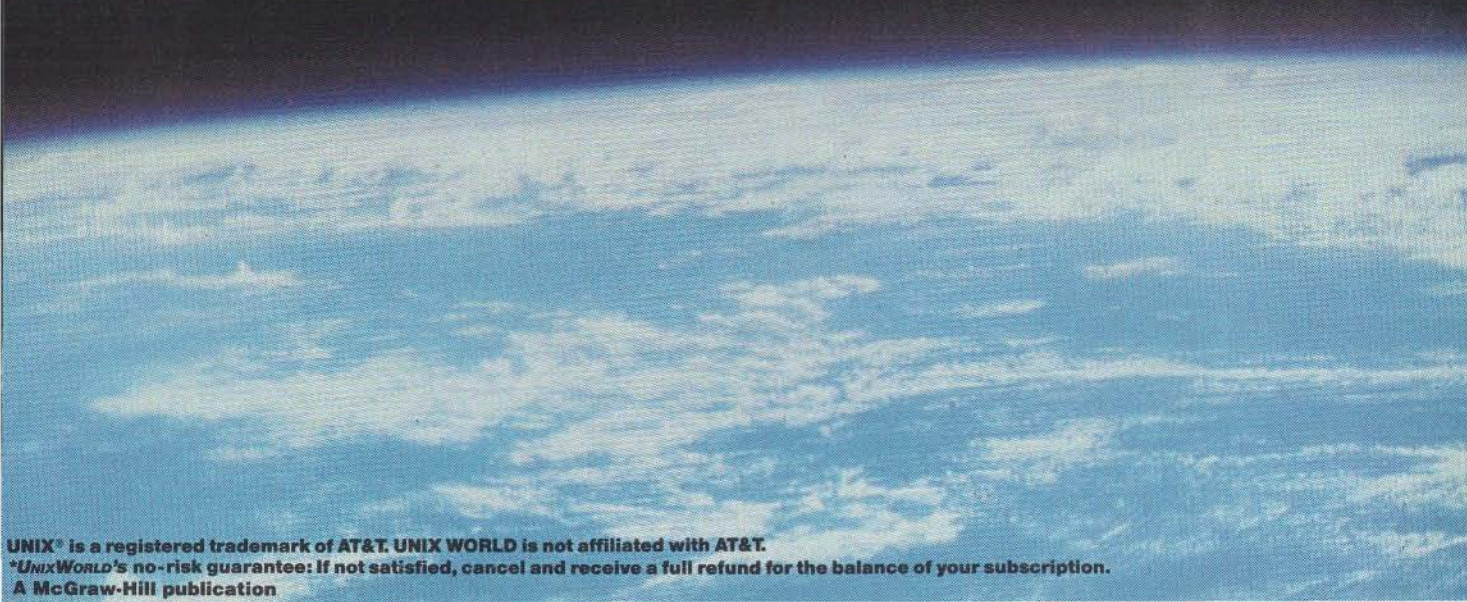

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state information must be carried with each request rather than cached on the server. The cost is speed. It is fast enough to be useful, however, and hooking up is quite simple.

For NFS to work, the Unix server must "export" any portion of the file system that it shares with other nodes. Each DOS client must have a valid Unix log-in and permission to access the server. The DOS user "mounts" the Unix file system, and it becomes an ordinary DOS lettered drive, which can be used like any other network drive. I've run floppy disk–based PCs as diskless workstations using NFS, and the performance was good enough that I didn't go nuts waiting for programs to load. But it wasn't really up to Novell standards. On the flip side, NFS doesn't cost as much as Novell, and Unix NFS servers can do real work while they babysit the file-sharing system.

Serving Up a Window System

As an illustration of a worthwhile client/server application, consider HCL-eXceed from Hummingbird Communications. This product is a full MS-DOS port of MIT's X Window (X11 release 3) server. It makes network connections through a set of functions that make calls into the PC/TCP kernel.

An X Window server is a hungry critter, consuming memory for every window, font, picture, client connection, or other resource. The paltry 640K bytes available to DOS, less about 90K bytes for the PC/TCP kernel, and less DOS overhead, is not enough to run a demanding X Window session. Anyone who wishes to port network clients or servers over from other environments can expect to encounter the problem of severe memory restrictions; DOS seems to stand alone in the limits it places on programmers. HCL-eXceed manages to deal with these in a couple of interesting ways.

First, the standard-issue version of HCL-eXceed (which runs on any DOS system) is tuned to reach out for any extra memory it finds available. If EMS memory is found, it will use as much as you choose to allocate. There is also a 64K-byte

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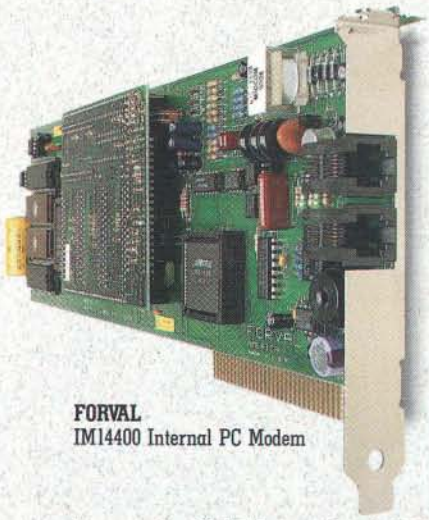

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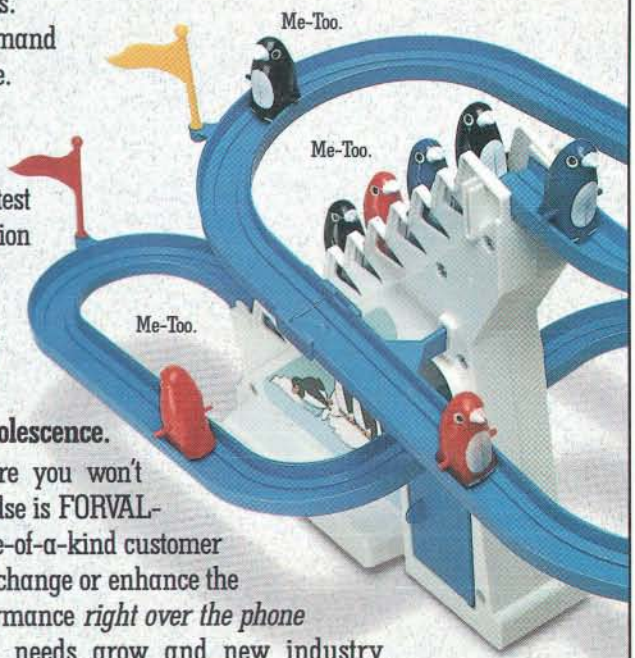

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"himem" area available on most PCs, which HCL-eXceed can use through a device driver. The preferred solution, and one that is growing in popularity, is to run the application in protected mode. In HCL-eXceed Plus, a DOS extender arranges for the X Window server to have access to all of a 286, 386, or 486's address space as a linear unit (just like a "real" computer) and manages the switch between protected and real modes when DOS services are needed. Similarly, since the PC/TCP kernel loads under DOS, each call to it invokes a shift to real mode. On a capable (286 or better) machine, this switch happens fast enough that you'll never notice.

When the HCL-eXceed server is started, it opens a network connection, or *socket*, and waits for a client to connect. To save you the inconvenience of trotting to another system to start the client, HCL-eXceed can start up a `telnet` remote log-in session. The DOS user logs onto a remote Unix host and enters the command to start the client program. This client locates the HCL-eXceed server's socket and attaches itself. Once the connection is established, HCL-eXceed switches from text (`telnet`) to graphics mode, and the session is under way. Even though DOS is single-tasking, a single HCL-eXceed server can support connections with multiple machines, and multiple clients per connection. X Window server commands are queued and processed sequentially, no matter how many clients are generating them.

Because the protocol between X Window servers and clients is a well-documented standard, any server that offers a proper X Window protocol can merge nicely into a network of differing machines. The portion of the application that communicates with the network needn't change in order to bring new functionality to bear. Whether HCL-eXceed runs on a 286 or a 486, in protected mode or real mode, on a VGA or 8514/A video controller, an incoming X Window client won't know the difference. This also frees you to shop for price, performance, and features, in whatever combination pleases you.

The Net Sum

Any good package is the sum of its parts, and connecting a DOS system to a Unix network offers an array of services that can help even the most harried system administrator get more from limited resources. There are other paths to achieving some of the ends described here. Racal InterLan, for instance, offers a card that installs in a Novell server and distributes file transfer and remote log-in services to Novell DOS client machines. Xircom offers a Pocket Ethernet Adapter that attaches to a parallel port to give any machine (even a floppy disk–based laptop) access to a Unix network.

There are also other TCP/IP packages for DOS, and other X Window servers as well. I've limited myself to writing about that with which I have direct experience, but you should examine all your available options. The most important thing to remember is that setting things up is the hardest part of any Unix network. Once it's put together, connecting new hosts—be they DOS, Unix, or what-have-you—is simple, and making use of the new services is downright monkey work.

If DOS has a future at all, it lies in the ability to communicate with more capable machines and operating systems. The little effort you'll expend to connect your DOS systems to a Unix network can pay off handsomely, but you need to take that first step. Even if the benefits aren't immediately obvious, you'll be surprised how many useful solutions will spring out of the connection you've made. ■

Tom Yager is a technical editor at BYTE. He can be reached on BIX as "tyager."

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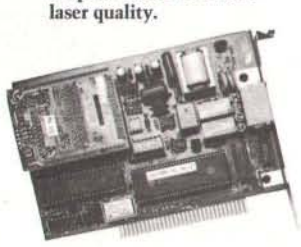

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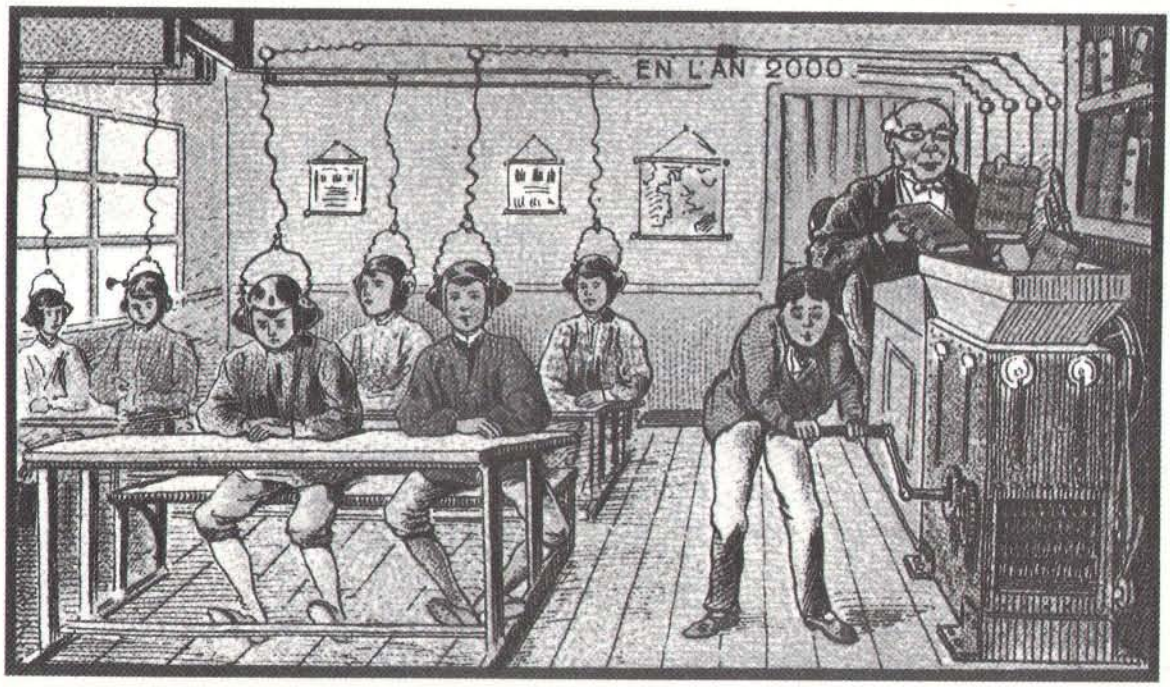

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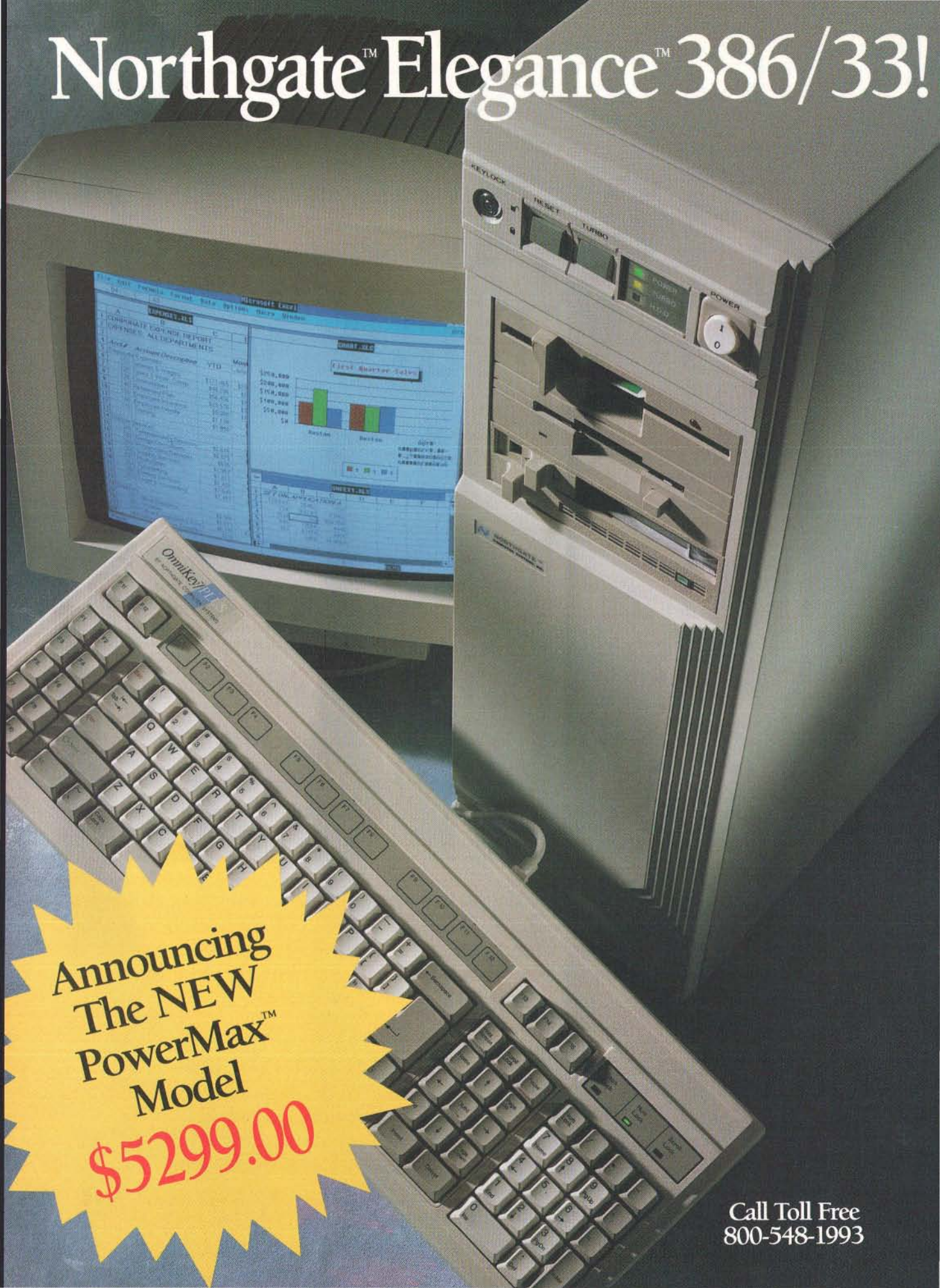

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THE EVOLUTION OF ESDI

Enhanced small device interface keeps pace with today's fast hard disk drives

In the late 1970s, Al Shugart of Seagate Technology (then Shugart Technology) developed the ST506 hard disk interface. In the spring of 1980, Seagate introduced the 5-megabyte ST506 drive that became the namesake for the interface. Several years later, Seagate introduced its 10-MB ST412 with essentially the same interface.

The ST412's interface, however, included one additional feature that the ST506 lacked—buffered seeks. Most ST506 controllers and drives today support the buffered seek option; they're commonly called ST506/412 devices.

The ST506 featured modified frequency modulation (MFM) data encoding and could transfer data to and from the hard disk drive at 5 megabits per second. With an eager and widening market at hand, the disk drive industry evolved rapidly. Soon hard disks could handle 10-Mbps transfers, and several disk drive, tape drive, and controller manufacturers saw the need for a faster interface. They agreed that an enhanced, electrically compatible version of the de facto standard ST506 interface made sense.

An ad hoc consortium formed, and the first working document for the new interface—the enhanced small disk interface—appeared in May 1983. The enhanced small tape interface followed, and in October of that year, the group decided to merge the two interfaces into a single document, ESDI (enhanced small device interface). The interface touted a 10-Mbps transfer rate, which is double that of the ST506.

By 1985, optical disks were coming on strong, and a draft of the ESDI specification that supported them appeared in March of that year. As industry acceptance of ESDI continued to grow, it emerged as a potential American National Standard. In January 1986, an ESDI steering committee formed, and the Accredited Standards Committee X3T9.3 working group held its first meeting in July of that year.

ESDI continued to find favor with manufacturers of high-performance hard disk drives but didn't do as well in the tape industry. In May 1987, ESDI proponents agreed to drop tape support from the proposed standard.

Early this year, ANSI finally adopted ESDI officially as ANSI X3.170-1990. Figure 1 shows a time line for the development of ESDI.

Two Standards: ESDI and SCSI

As ESDI developed and became a standard, so did another interface designed to support high-speed disk drives and other peripherals—ANSI's X3T9.2 committee directed the standardization of SCSI. It became an official standard in 1986 as ANSI X3.131-1986. A second-generation specification, SCSI-2, is now nearing completion.

SCSI often competes with ESDI for control of high-performance hard disk drives in today's fast PCs. As I take a closer look at ESDI, I'll point out some of the key comparisons between the two interfaces and try to clarify their applications. (For a detailed look at SCSI, see Under the Hood in the February and March BYTE.)

ESDI now finds wide acceptance in the PC marketplace. Manufacturers including IBM, Compaq, and Dell use ESDI hard disk drive subsystems in their high-performance machines. With Apple computers, of course, it's a different story. Apple chose to make a SCSI connection standard equipment on the Macintosh.

How ESDI Works

ESDI is a device-level interface. It connects directly to the hard disk drive and controls basic operations, such as seek and head select. SCSI, in contrast, is a system-level interface, or bus, that can connect to any of a wide variety of devices simultaneously (including hard disk drives, scanners, optical disks, printers, and tape drives) and can communicate with them by means of high-level commands. A SCSI hard disk drive needs intelligent SCSI electronics and a device-level connection for controlling the disk. The latter could, in theory, be an ESDI connection or something similar.

Electrically and mechanically, ESDI looks just like the ST506 interface. A common 34-conductor control cable connects in daisy-chain fashion to all drives controlled by a single controller. Each drive has its own 20-conductor data cable. Even the popular four-pin power connector found on all standard PC floppy and hard disk drives is defined as part of the ESDI standard.

While most of the ESDI signals are single-ended open-collector TTL (a single wire referenced to a common ground), the clock and data signals are differential (a complementary pair of wires, where only the voltage difference between the wires is significant). That design maintains integrity even at very fast data transfer rates. ESDI permits cable lengths of up to 3 meters (a little over 9 feet).

Interface Signals

Table 1 shows the ESDI signal definitions for the 34-conductor and 20-conductor cables. I've included the ST506 signal definitions for comparison. ESDI hard disk and optical disk connections

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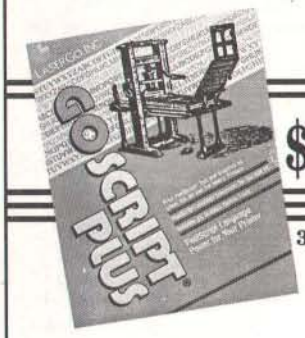

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work in slightly different ways; I'll focus on hard disk applications.

An ESDI controller can accommodate as many as seven drives, although ESDI controllers used in PCs typically support just two. Three drive-select signals determine the active drive, in a binary fashion. When all three drive-select signals are unasserted (low), no drive is selected.

Four head-select signals pick one of up to 16 heads on the active drive. What if your drive has more than 16 heads? That's handled by means of the Select Head Group command. When the drive reaches its operating speed, it sends a ready signal to the controller. It also sends the index signal, the rising edge of which indicates the beginning of each track. The index signal, which pulses once per revolution of the platters, also appears on the data cable.

The function of the sector/address mark found signal varies depending on whether the disk incorporates hard sectoring or soft sectoring. With hard sectoring, drive electronics determine a fixed number of sectors per track. The drive pulses the sector/address mark found line at the start of each sector. You don't find many hard-sectored disks these days—I can't think of any offhand—but, nevertheless, ESDI supports them.

With soft sectoring, the disk's operating software determines the number of sectors per track. Address marks—codes placed on the platter before the sector data—delineate sectors. When the drive detects a mark, it pulses sector/address mark found.

Finally, the read gate signal enables the selected read/write head for a read operation, and write gate sets up a write operation.

On the data cable, the drive-selected signal tells the controller that there is indeed one, and only one, drive at the specified drive-select address. And the address mark enable signal tells a soft-sectored drive to write an address mark at the current position of the selected read/write head. Utility programs can use this signal, valid only when write gate is asserted, to change the number of sectors per track.

Moving the Data

Four differential (or balanced) signals affect data transfer between the controller and the hard disk: write data, read data, write clock, and read/reference clock. Data transfer requires both clock and data signals. The clock signal indicates when the data signal is valid. Typically, the rising edge of each clock cycle indicates the start of a new data bit in a serial data stream. In its purest form, data and clock are physically separate signals; this scheme is called NRZ (non-return-to-zero) encoding. Figure 2 illustrates NRZ encoding of a serial bit stream.

But to store data on a hard disk platter, you've got to combine the data and clock signals. Encoding methods that can do that include FM, MFM, and run length

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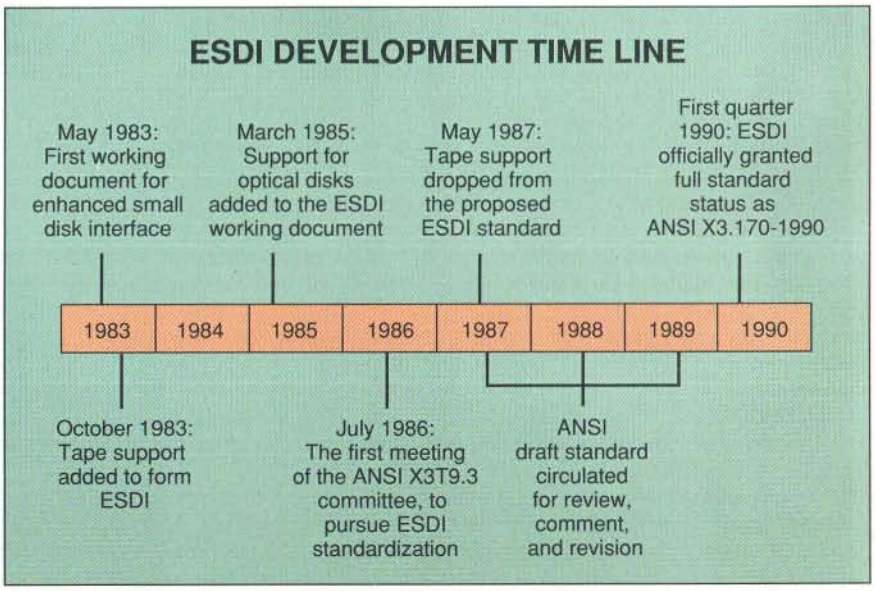

Figure 1: *Seven years in the making, ESDI's ANSI certification finally came this year.*

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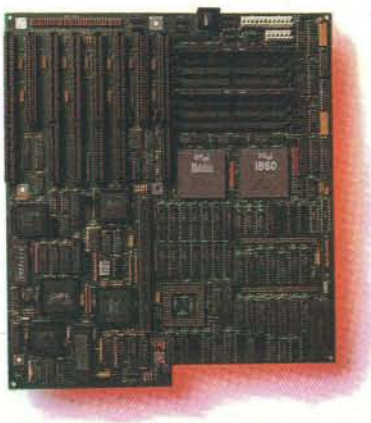

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limited (RLL). Figure 3 illustrates MFM encoding. If there's a transition at the center of a bit cell, the bit is a binary one; otherwise, it's a zero. Transitions also occur at the beginning of each zero-bit cell that is preceded by another zero-bit cell.

It's reasonably straightforward to encode these various formats when writing to the disk but a lot harder to decode them when reading the disk. A special circuit called a *data separator* does the job. It incorporates a phase-locked loop circuit to synchronize with and lock onto the clock as it's recovered from the encoded signal. For reliable data and clock separation, the encoded signal has to be free of electrical noise.

The basic ST506 interface transfers data between the controller and the hard disk drive in MFM format at 5 Mbps. For several years now, ST506 controllers and drives have also been available that use RLL encoding instead of MFM. That buys a 50 percent increase in the data transfer rate—to 7.5 Mbps—and also boosts storage capacity by 50 percent. RLL encoding is more complex than MFM and requires a more advanced data separator. Nevertheless, most new drives use it.

Since the ST506 controller transfers encoded information to and from the drive, the data separator has to reside on the controller. The developers of ESDI realized that encoded data sent over long cables might not transfer reliably at 10 Mbps. So ESDI transfers NRZ data between the controller and the hard disk drive and uses separate, balanced data and clock signals. The hard disk drive itself has to encode the data before storing it on its platters, and it must also incorporate a data separator to decode the data.

This approach makes the drives attached to an ESDI controller more complex—and more costly—than ones used in an ST506 subsystem. And each drive needs its own data separator; there's no way to share a single, controller-resident separator. But the benefits outweigh the drawbacks. The scheme ensures superior data integrity, and the encoding scheme no longer depends on the controller. An ESDI hard disk drive can use one of several flavors of RLL encoding, or

continued

SIGNAL DEFINITIONS FOR ESDI AND ST506

Table 1: ESDI and ST506 use the same connectors. However, ESDI's high-level command orientation differs markedly from that of the older ST506 interface (N/A = not applicable). Head and drive selection bits appear in parentheses.

34-CONDUCTOR CONTROL CABLE, ESDI

Signal	Direction	Signal pin	Ground pin
Head select 2(3)	To disk	2	1
Head select 2(2)	To disk	4	3
Write gate	To disk	6	5
Config/status data	From disk	8	7
Transfer acknowledged	From disk	10	9
Attention	From disk	12	11
Head select 2(0)	To disk	14	13
Sector/address mark found	From disk	16	15
Head select 2(1)	To disk	18	17
Index	From disk	20	19
Ready	From disk	22	21
Transfer request	To disk	24	23
Drive select 2(0)	To disk	26	25
Drive select 2(1)	To disk	28	27
Drive select 2(2)	To disk	30	29
Read gate	To disk	32	31
Command data	To disk	34	33

34-CONDUCTOR CONTROL CABLE, ST506

Signal	Direction	Signal pin	Ground pin
Reserved	N/A	2	1
Head select 2	To disk	4	3
Write gate	To disk	6	5
Seek complete	From disk	8	7
Track 0	From disk	10	9
Write fault	From disk	12	11
Head select 0	To disk	14	13
(looped to pin 7 of data connector on disk)		16	15
Head select 1	To disk	18	17
Index	From disk	20	19
Ready	From disk	22	21
Step	To disk	24	23
Drive select 1	To disk	26	25
Drive select 2	To disk	28	27
Drive select 3	To disk	30	29
Drive select 4	To disk	32	31
Direction in	To disk	34	33

20-CONDUCTOR DATA CABLE, ESDI

Signal	Direction	Signal pin	Ground pin
Drive selected	From disk	1	N/A
Sector/address mark found	From disk	2	N/A
Command complete	From disk	3	N/A
Address mark enable	To disk	4	5
+Write clock	To disk	7	6
–Write clock	To disk	8	9
+Read/reference clock	From disk	10	N/A
–Read/reference clock	From disk	11	12
+Write data	To disk	13	N/A
–Write data	To disk	14	15
+Read data	From disk	17	16
–Read data	From disk	18	19
Index	From disk	20	N/A

20-CONDUCTOR DATA CABLE, ST506

Signal	Direction	Signal pin	Ground pin
Drive selected	From disk	1	2
Reserved	N/A	3	4
Reserved	N/A	5	6
(to pin 16 of control connector on disk)	N/A	7	8
Reserved	N/A	9	
Reserved	N/A	10	11
+Write data	To disk	13	12
–Write data	To disk	14	15
+Read data	From disk	17	16
–Read data	From disk	18	19,20

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even MFM encoding. (I don't know of any ESDI drives that use MFM, but it's possible.) It's even possible to mix encoding methods within a multidrive ESDI subsystem.

Decoded data shows up on the data cable as the read data signal. The read/reference clock signal, which the hard disk drive generates, controls the timing of both read and write operations. When read gate is active, read/reference clock acts as the read clock, carrying the clock signal that the data separator extracts from the stored clock/data information. When there's no read in progress, the hard disk drive generates a reference clock signal on the read/reference clock line.

The controller uses the write data signal to present NRZ data to the hard disk drive. The write clock signal—derived from the hard disk drive's reference clock—provides the timing clock for the write data signal. Note that the hard disk drive controls both the read and write data transfer rates—it must, since it has control over its own data encoding scheme.

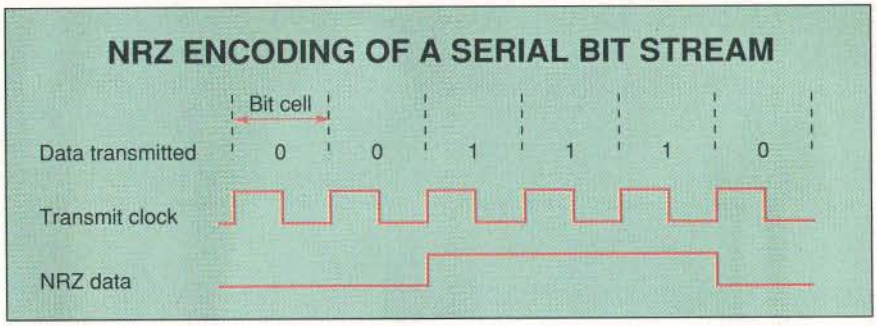

Figure 2: *To distinguish bits in NRZ data, you need a separate source of clock information.*

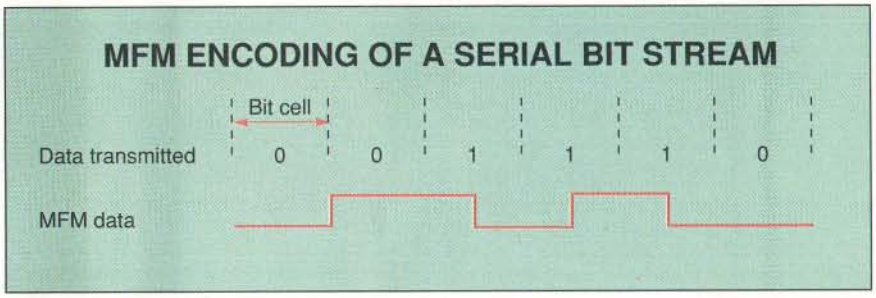

Figure 3: *MFM encoding (like RLL encoding) merges data and clock information into a single, combined signal.*

ESDI SERIAL-MODE COMMANDS

Table 2: The 16-bit command word includes a 4-bit command identifier (bits 15–12), and it can also include modifier, subscript, and parameter values (bits 11–0) (●=yes, ○=no).

Command number (bits 15–12)	Command definition	Command modifier (bits 11–8)	Command subscript (bits 7–0)	Command parameter (bits 11–0)
0000 (0)	Seek	○	○	●
0001 (1)	Recalibrate	○	○	○
0010 (2)	Request Status	●	●	○
0011 (3)	Request Configuration	●	●	○
0100 (4)	* Select Head Group	○	○	●
0101 (5)	Control	●	○	○
0110 (6)	* Data Strobe Offset	●	○	○
0111 (7)	* Track Offset	●	○	○
1000 (8)	* Initiate Diagnostics	○	○	●
1001 (9)	* Set Bytes per Sector	○	○	●
1010 (10)	* Set High Order Value	●	○	●
1011 (11)	Reserved	○	○	○
1100 (12)	Reserved	○	○	○
1101 (13)	Reserved	○	○	○
1110 (14)	* Set Configuration	●	●	○
1111 (15)	Reserved	○	○	○

*optional commands

The Serial Command Mode

Five signals on the control cable and one on the data cable communicate commands and status information between the controller and the drive: config/status data, transfer acknowledged, attention, transfer request, command data, and command complete. The controller sends 17-bit command-plus-parity words to the controller serially. It places each bit on the command data line, asserts the transfer request handshake signal to the hard disk drive, and awaits the transfer acknowledged return handshake signal from the hard disk drive. Configuration and status information returns to the controller in a similar fashion.

Two other signals figure importantly in ESDI's serial command mode: attention and command complete. The hard disk drive asserts attention when it wants the controller to request its standard status. That's generally a response to a fault condition on the hard disk. Writing to the hard disk can't occur while attention is asserted.

Command complete is the only serial mode signal on the data cable. The hard disk drive generates it. When unasserted, it tells the controller that the drive can't respond to the interface—typically, because the drive is trying to recover from an error or is performing another internal function.

Commanding the Drive

ESDI defines 12 commands for use with hard disk drives, as shown in table 2. Just five are mandatory. The high-order 4 bits of the 16-bit command word determine the command type; the low-order 12 bits can contain supplemental command information. The commands also include a trailing parity bit.

Seek causes the drive to seek to the

continued

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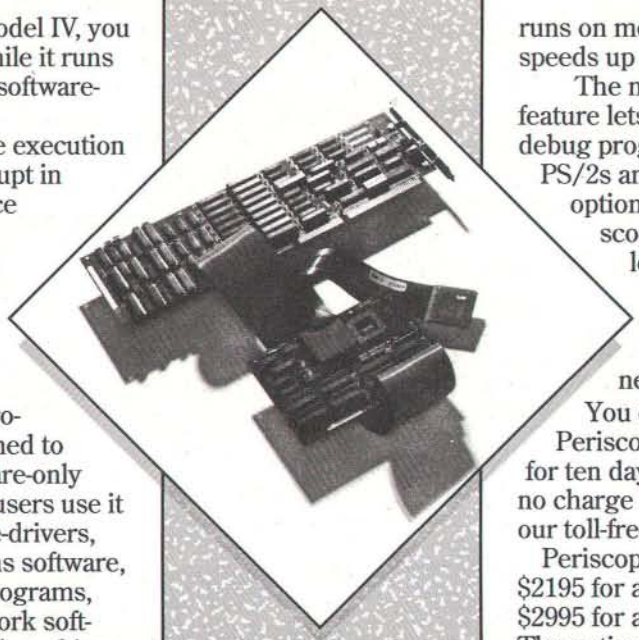

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cylinder specified by the low-order 12 bits of the command word. Recalibrate sends the heads to cylinder zero and restores the drive's data strobe offset and track offset values to zero. Request Status solicits 16 bits of standard or vendor-specific status information, based on the command modifier bits.

Request Configuration can solicit the drive's transfer rate, number of heads, number of cylinders, hard/soft sectoring information, and much more. The Control command resets certain functions (including the interface attention after a fault), and it can also optionally implement spindle on/off control commands. (I suppose this would be helpful if you're using an ESDI drive in a laptop.)

Optional Commands

Select Head Group supports drives with more than 16 heads. A 4-bit value selects one of 16 head groups, each of which contains 16 heads. Data Strobe Offset and Track Offset address specific regions of the disk; data recovery utilities can use these commands. Initiate Diagnostics tells the hard disk drive to run its internal diagnostics, if any.

Set Bytes per Sector works with hard-sectored disks; it can adjust the number of bytes stored in each sector. Set Configuration has several applications. It can, for example, set varying transfer rates for different cylinders of the disk, on hard disk drives that support zone recording. It can also support hard disk drives that change angular velocity (rotational speed) at different cylinder ranges to maintain a relatively constant linear velocity.

Putting ESDI to Work

ESDI has capacity to spare. A single ESDI hard disk drive can hold a terabyte of data. Even if you stick to the 512-byte sectors that DOS and OS/2 prefer, the limit is a healthy 137 gigabytes.

And, of course, it's fast. Most ESDI drives today transfer at 10 Mbps, but 15-Mbps drives have started to appear. And the theoretical limit, 24 Mbps, leaves plenty of room for further performance improvements.

ESDI expects a 1-to-1 interleave; it would make little sense to operate such a high-performance interface any other way. While some recent ST506 interface implementations can now also operate at a 1-to-1 interleave on high-performance PCs, the data transfer rate of these interfaces still restricts the overall performance potential of the hard disk drive subsystem.

If you're familiar with the ST506 interface, you'll find connecting an ESDI hard disk drive to its controller virtually identical. The controller will have a 34-pin header connector for the control cable, and the hard disk drive will have a 34-contact card-edge connector to mate with the ribbon cable. Similarly, the controller will have a 20-pin header connector for each hard disk drive it supports (typically two), into which you will plug the 20-conductor data cable. And the hard disk drive will have a 20-contact card edge connector that also mates with the 20-conductor cable. Both card-edge connectors on the ESDI hard disk drive must have a key slot, per the ESDI standard, and any good drive cables should incorporate the key to keep the cables from being connected to the drive incorrectly. The ESDI drive will also ac-

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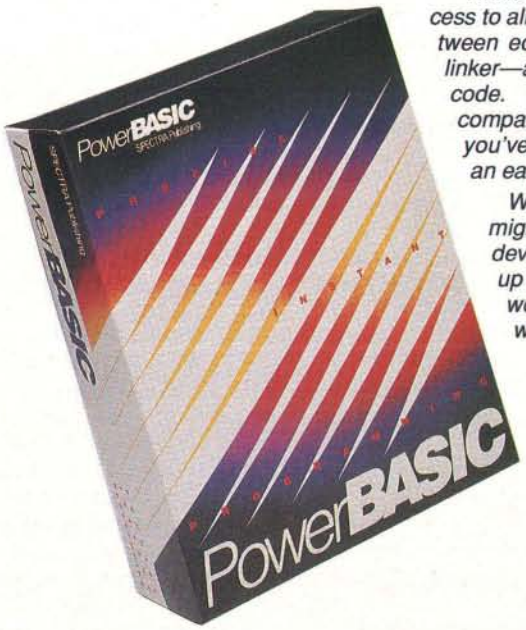

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cept the standard four-pin PC power connector.

Standard ST506/MFM hard disk drives are formatted for 17 sectors per track. The higher density and higher data transfer rate of ST506/RLL hard disk drives require the number of sectors per track to increase to 26. With most current ESDI hard disk drives in the PC marketplace operating at 10 Mbps, these drives are typically formatted for 32 to 35 sectors per track; most use 34 or 35.

The Software Environment

How compatible is ESDI with your software? That depends. If you inhabit the DOS world exclusively, all ESDI controllers for PCs will work acceptably. Some have their own BIOS-level driver. Others take great pains to emulate the ST506 interface found on IBM's original AT system. That means the interface can work with the hard disk driver that is already resident in the system's ROM BIOS.

If you want to use an ESDI subsystem under OS/2 or Xenix, things aren't quite so automatic. A WD1003-compatible controller should work acceptably, but controllers with their own driver could have a problem. If you buy IBM's ESDI hard disk drive subsystem, you can rest assured it will work with IBM's OS/2. Similarly, Dell's ESDI subsystem will work with that company's version of OS/2. When in doubt, verify compatibility with the distributor or manufacturer of the ESDI controller before buying.

You'll also want to make sure that your ESDI controller will operate properly with the drive you select. There have been cases of drive/controller incompatibilities. Although the recent standardization of the ESDI connection has alleviated much of the concern, some ESDI hard disk drives implement special, optional functions; these require matching controllers. To avoid potential mix-and-match incompatibility problems, you can purchase an ESDI hard disk drive subsystem, including the controller and cables.

ESDI vs. SCSI

While SCSI's parallel bus implementation differs from ESDI's serial transfer approach, both interfaces support high-speed data transfers and require the hard disk drive to incorporate some intelligence. SCSI requires more intelligence, however, and entails more overhead. For this reason, ESDI subsystems often outperform similar SCSI subsystems in overall effective data transfer rate.

SCSI, however, holds an ace. A SCSI drive can accept a command, disconnect from the bus while processing it, and then reconnect to the host controller. That way, multiple SCSI drives can process commands or transfer data concurrently. Network controllers and multiuser systems that can apply this feature will undoubtedly embrace SCSI.

ESDI will continue to grow in popularity, probably at least into the mid-1990s. SCSI will also gain ground. As software standards develop that permit more-uniform use of SCSI controllers with a wide variety of peripherals (e.g., hard disk drives, optical disks, and scanners), it seems likely that SCSI will eventually become the dominant high-performance hard disk drive interface in the PC world. But for now, ESDI thrives. With practically unlimited capacity, plenty of room for performance gains, and an ANSI seal of approval, ESDI and fast PCs will march together for years to come. ■

Roger C. Alford is a computer design engineer and a freelance writer. He can be reached on BIX c/o "editors."

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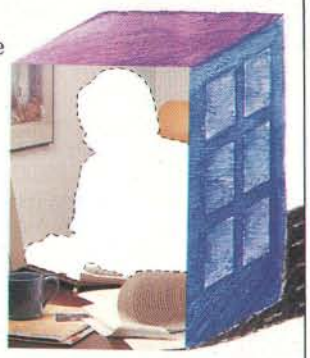

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All-Month Conferences and Special Events

■ **Amiga Exchange**—If you're an Amiga user, you'll want to visit 'amiga.special,' a conference in which Matt Dillon is discussing his network for the Amiga. Recently, BIXen worked on promoting it from a serial device network to a parallel device network. (join amiga.special/matt.dillon)

■ **Datem Conference**—In this conference, Datem Ltd., a manufacturer of BITBUS technology products, is holding discussions on BITBUS network systems and their use. The BITBUS network is a single-master, multiple-slave network topology, optimized for short control messages between a cell controller (such as a VAX or PC) and multiple I/O controllers. (join datem)

■ **Science-Fiction Conference**—Every Thursday night, beginning at 6:30 PST, you can discuss your favorite (or least-favorite) science-fiction books and authors, conventions, movies, TV series, Japanese animation, or comic books. You can also visit with guest authors who, in the recent past, have included the likes of Marion Zimmer Bradley and Steve Boyett. (join sf/cbix)

BIX Conference News

■ **Read Hugh Kenner's reviews** of books on computers and related areas of high technology—before they appear in BYTE—in a new conference called 'print.queue.' Kenner is one of America's foremost literary critics, and author of the *Print Queue* column in BYTE. (join print.queue)

■ **Bytis Permutatio Informationum** (BIX) omnis divisa est in partes duo, quorum in una, quae nobis cordi est, nunc de lingua Graeca Latinaque disputatur. Quin etiam lectiones Latinae offerantur. (lungite [join] writers.talk/classix et writers.talk/ learn.classix)

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■ **Foxbase, dBase, and Clipper** programmers and users are invited to share their insights in the 'clipper' conference. (join clipper)

■ **Learn the science of weather** and natural disasters from *Chicago Sun-Times* Meteorologist Brendan Larson. (join disasters/weather)

■ **Adrian Aylward's postscript emulator** Version 1.1 will be on the market any day, now, and you can discuss it in depth with Aylward himself. (join amiga.special/postscript)

■ **Solid Software, Inc.'s** Dwight Merriman and Taylor Hutt will show you how to develop with Modula 2, in a CBix session on Tuesday, June 12, at 7:30 PM, EDT. Emphasis will be on Solid Windows Professional. (join solid/cbix)

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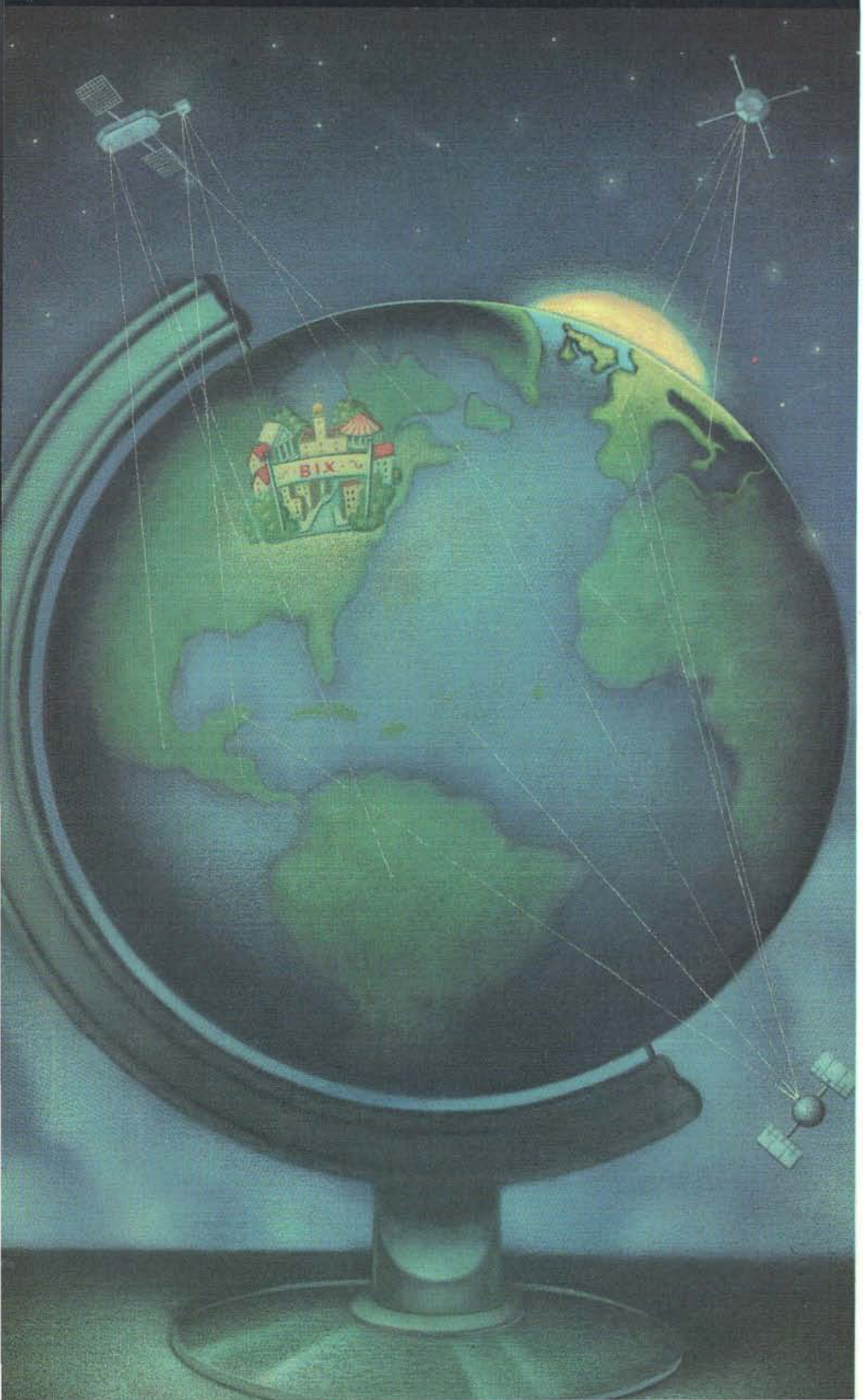

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CLOAK AND DATA

Using secret codes to secure your data from prying eyes

One thing about computers—they keep secrets well. You can keep them up all night under a glaring light, and they won't break. This makes them particularly trustworthy. If a computer wants to conceal something from you, you have to beat the information out of it—mathematically speaking.

Privacy is becoming more and more important in these days of personal computers that are looking less and less personal. Most of the machines at BYTE are on one network or another, and it's not uncommon to find that the route a file has taken from source to ultimate destination leads through more than one hard disk. Fortunately, much of the data we deal with is no more sensitive than next month's columns (embargoed information is closely monitored).

But there are those times when you want information to stay confidential: when you've got to get a file from one end of the country to the other and you really don't know who might "accidentally" eavesdrop, for example. Or you've saved a directory full of sensitive information on your disk just before a week's vacation, and you'd like to be able to sleep at night. It's not that you don't trust anybody, it's just that...well...you don't trust *everybody*. So, you encrypt it.

In most cases, the security of a cryptographic system rests on the concealment of a key. Once the bad guys (i.e., anyone into whose hands you don't want the information to fall) get the key, you assume they know how to use it to unlock the encrypted message. (I'll refer to the encrypted message as the *ciphertext* and the unencrypted message as the *plaintext*.)

Other systems rely on a trick. There is no key; instead, the plaintext has been concealed by a method that—you hope—is so devious that no one will discover it.

Finally, there are the public-key cryptosystems. These employ two keys: one secret key that you keep to yourself, and another public key that anyone sending a message to you can use to encrypt the correspondence. The public key is derived from the secret key (or vice versa), and you don't care if the bad guys get the public key. Even if they did, cracking the message would involve using algorithms that would take so long to arrive at a solution that the effort isn't worth it. You hope.

Kid Caesar

The simplest of ciphers, and one you probably toyed with when swapping secret notes in the third grade, is the letter substitution cipher. This sort of encryption is often called a *Caesar cipher* after Julius Caesar. He used to write his messages down and then encode them by taking each letter and replacing it with the character three letters up in the alphabet. I suppose that way, if his delivery boy got nabbed by Gallic strongarms, the bad guys would be stumped by the unreadable message, and the whereabouts of the next siege would stay a mystery.

Putting together a program to encrypt files using a Caesar cipher is trivial. Of course, it also doesn't require a lot of noodlework to crack a Caesar-ciphered message. My mom used to pick up crossword puzzle books at the A&P checkout line and breeze through the page of coded messages after she'd cleaned up all the anacrostics. Those messages were all done in letter-substitution code, and she didn't have much trouble with them.

The Caesar cipher is a simple kind of monoalphabetic substitution cipher—a

continued

ILLUSTRATION: PAUL SCHULENBURG © 1988

fancy way of saying that each character in the plaintext is replaced by some other character chosen from a host alphabet. The method guiding the encryption can be as simple as "skip up the alphabet three letters" (the Caesar cipher) or as complex as writing *A* to *Z* on one line, writing a randomly jumbled list of letters below it, and encrypting by matching each plaintext character with itself on the top line and writing down the corresponding character from the bottom line.

Unfortunately, no method can mask the letter frequency of the underlying plaintext's language, and a seasoned codebreaker can use letter-frequency analysis to help in cracking the code. This is the greatest weakness of monoalphabetic substitution ciphers—which leads us to mankind's next attempt to keep secrets secret: polyalphabetic substitution ciphers.

Probably the most famous of this type is the Vigenère cipher, developed by the French diplomat Blase de Vigenère. To encrypt a message, you need a key consisting of as many characters as your plaintext message. Usually, you pick a word and repeat its characters as necessary. As you step through the plaintext message, each corresponding character in the keyword determines the amount by which you shift the plaintext character to get the corresponding encrypted character: *A* means a shift of 0, *B* means a shift of 1, and so on. If you end up shifting beyond the end of the alphabet, you circle back around to its beginning. To encrypt FIFTEEN YEARS AGO using the keyword BYTE, you have

```
BYTEBYTEBYTEBYT (keyword)
FIFTEENYEARSAGO (plaintext)
```

which yields

```
GGYXFBGCFYKWBEG
```

as the ciphertext.

Vigenère constructed a large matrix—26 characters on a side and holding 26 shifted alphabets—to make the encrypting process easier.

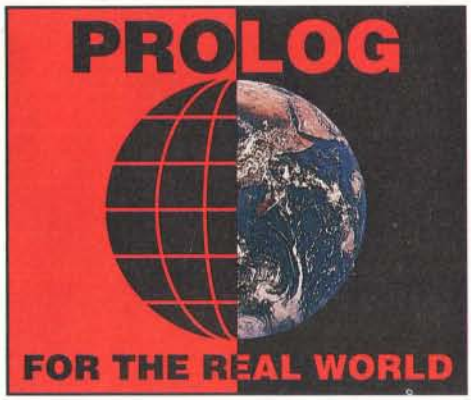
The Vigenère cipher does a good job of jumbling letter frequencies, so cracking such a message is harder than with Caesar-cipher codes. One technique used to break a Vigenère message employs any resonance that might take place between the plaintext message and the key. This happens if repeated words in the plaintext message line up more than once with the first character of the key and thus produce identical sequences of ciphertext characters. A codebreaker could use this to guess the character length of the key.

If the codebreaker successfully deduces that the length of the key is, say, *n*, he or she would build subsets of characters from the ciphertext—the first subset consisting of each *n*th character, the next consisting of each $(n+1)$th character, and so on. The codebreaker then writes these subsets as rows and attacks each row as a monoalphabetic cipher, watching all the while for recognizable words to form in the columns. Sounds like a pain, but, trust me, there are people who love this stuff.

Suitably Computable

The famous exclusive-OR cipher has been independently discovered and rediscovered by nearly every computer science student that ever banged a teletype. Remember how the exclusive-OR operation works? Here's a refresher in binary:

continued



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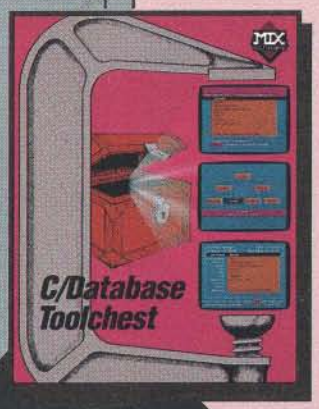

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Circle 196 on Reader Service Card

```
1 XOR 0 = 1
1 XOR 1 = 0
0 XOR 0 = 0
```

See anything special? Maybe something like a XOR $b = c$ and c XOR $b = a$? That means that if you XOR a message with a key, you can take the result, perform the XOR operation again, and recover the original message.

Turns out this one's got a guy's name on it, too: the Vernam cipher. Gilbert Vernam was working for AT&T in 1917 and had a bunch of paper tape readers and punch machines sitting around. He rigged three of them so that you fed two paper tapes through a pair of readers and their output was XORed together and sent to a tape punch. You made one tape that was your key tape, punched your message onto a second tape, and ran them both through Vernam's machine. The output tape was encrypted. To decode it, you ran it *back* through the machine with the key tape.

This was hot stuff. If the data on your key tape was really random, the message on the encrypted tape was locked up solid: You'd *have* to have the key tape to decode it. In World War II, the Germans used this technique to create encrypting machines called Lorenz machines. The only real problem with this scheme is that the key tape is just as big as the message tape, so you've got two tapes to transport in secret to your recipient.

A way out of this would be to put together some algorithm that produces a stream of random numbers that you use as the key. The seed for your random number generator then becomes the key. Trouble is, you have to make sure the stream is long enough and the bad guys don't figure out how your random number generator works. It turns out that knowing the length of the key stream opens the door for cracking a Vernam-ciphered message (see Cooper's book in the bibliography).

The Sir Francis Bacon (SFB) cipher, named after its inventor, should have a particular appeal to regular readers of BYTE. Even though Bacon didn't have a PC next to his inkwell, this cipher is based on the binary number system.

Take each character of a message and look at the binary representation of that character's ASCII code:

```
B = 01000010
Y = 01011001
T = 01010100
E = 01000101
```

Now, replace each 1 with an even digit and each 0 with an odd digit. The message is now

```
76335723 12344772 92743422
58555236
```

Of course, the items used to represent the 1s and 0s don't have to be even and odd digits. They could be vowels and consonants, or whatever your imagination can dream up. It doesn't take a lot of oogling to see that one big problem with the SFB cipher is that it expands the original message—eightfold in my example. Also, this is a trick cipher. The key isn't some string of bytes; the key is a trick, and the security of the system depends on how well you can hide the trick. The giveaway in my example is that the number of digits in the ciphertext is a multiple of eight, which could lead a bad guy to deduce how the code works.

continued

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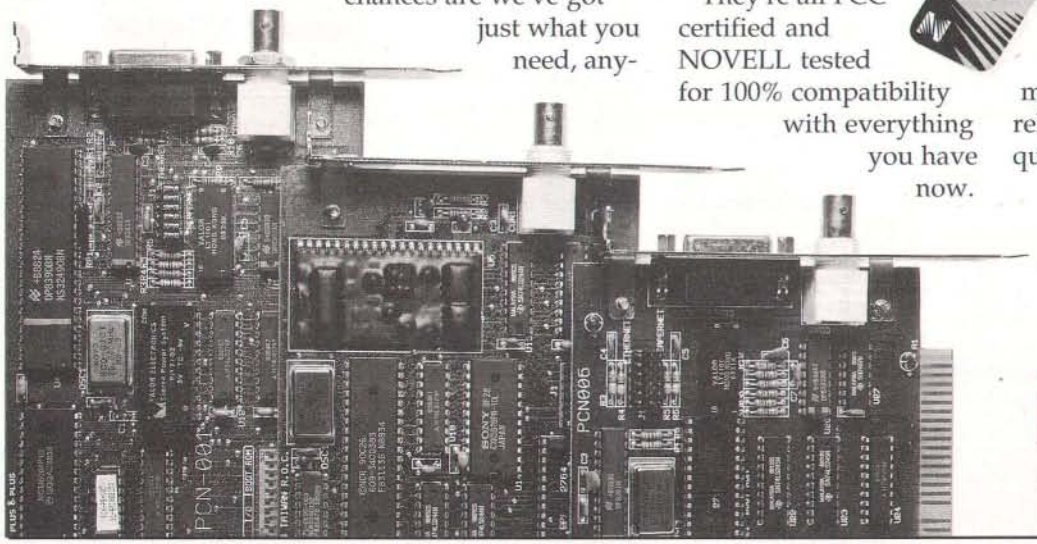

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:30 REGISTRATION & BREAKFAST

:30 **TUTORIALS**

Introduction to Object-Oriented Technology (Code: TI)
John Potter, University of Technology, Sydney (Australia)
Case Studies in Object-Oriented Analysis (Code: TA1)
Jean-Marc Nerson, ISE (USA)
Concurrent Object-Oriented Programming (Code: TP)
Mario Tokoro, Keio U. (Japan), JP Briot, CNRS (France)
Introduction to Object-Oriented Data Management (Code: TD1)
Jacob Stein, Servio Logic (USA)

2:30 LUNCH

:00 **TUTORIALS**

Managing Object-Oriented Software Engineering (Code: TM)
Ivar Jacobson, Objective System AB (Sweden)
Dave Thomas, Carleton U. & CBI Systems (Canada)
Object-Oriented Design for User Interfaces (Code: TU)
Joelle Coutaz, LGI, IMAG, Grenoble (France)
Object-Oriented Structured Design (Code: TG)
Tony Wasserman, Peter Pircher, IDE (USA)
SIMULA for the Working Classes (Code: TS)
Ron Kerr, Newcastle, (UK)

/EDNESDAY, JUNE 27, 1990

:30 *Developing Quality Software with Eiffel* (Code: TE)
Philip Hucklesby, SOL (France)
Object-Oriented Database Systems (Code: TD2)
Francois Bancilhon, Altair (France)
Object-Oriented Programming in Smalltalk (Basics) (Code: TK1)
John Pugh & Wilf Lalonde, Carleton U. (USA)
HOOD (Hierarchical O-O Design(Code: TH)
Maurice Heitz, Cisi Ingenierie (France)

2:30 LUNCH

:00 *Introduction to C++*(Code: TC)
Robert Murray, AT&T (USA)
New Advances in Object-Oriented Analysis (Code: TA2)
Peter Coad, Object Internation Inc. (USA)
O.O. Programming in Smalltalk (Advanced Concepts) (Code: TK2)
John Pugh & Wilf Lalonde, Carleton U. (USA)
Problem Solving in Objective-C (Code: TO)
Jon Hopkins, Stepstone (USA)

THURSDAY, JUNE 28, 1990

TRACK A

Session A1: Introduction & Keynote (Chair: Bertrand Meyer)

:30 **Welcome and Introduction to TOOLS '90**
Jean Bézivin. Université de Nantes (France), Program Chairman

:00 **Keynote Lecture: *The Object-Oriented NeXTStep Interface***
Jean-Marie Hullot, NeXT Inc. (USA)

Session A2: TOOLKITS I (Chair: Ivar Jacobson)

0:30 *Knowledge Based Management of Software Objects*
J.M. Chauvet, Neuron Data (France)

1:00 *A Network Programming Package in Eiffel*
M.F. Hillman, Yale U. (USA)

1:30 *Object-Oriented Programming and the Design of an Open System for User Interfaces*
S. Koneeni & U I. de Zegher, BIM (Belgium)

2:00 *G++: An Environment for O-O Design and Prototyping*
G. Menga, M. Morisio, P. Picchiottino, Politecnico di Torino & G. Lo Russo, SYCO (Italy)

12:30 LUNCH

Session A3: Practical Experiences I (Chair: E. Zamani)

2:00 *Genericity, Inheritance and Relations: A Practical Perspective*
G.C. Murphy, Microtel Pacific Research (Canada)

2:30 *Object-Oriented Geo-Information Processingf in Modulex*
S. Alagic & Z. Galic, Sarajevo U. (Yugoslavia)

3:00 *An Object Approach of ODA Implementation for Technical Document Production*
J.C. Chabrier & J.M. Guillemin Laborne, U. Bourgogne (France)

Session A4: Practical Experiences II (Chair: Jon Hopkins)

4:00 *Strategic Defense Initiative (SDI) Software Reuse Issues*
J.S. Morrison, US Air Force (USA)

4:30 *Object-Oriented Technology and Reuse in Telecommunication Applications*
A. Sixtensson & W. Ye, Lund U. (Sweden)

5:00 *X, Golf and Object-Oriented Programming*
B. Yamrom & W.E. Lorensen, General Electric Research (USA)

Session A5: (Chair: Paúl Dubois)

4:45 Special presentation: *Sequential and Concurrent Object-Oriented Programming*
Bertrand Meyer, Interactive Software Engineering (USA)

TRACK B

Session B1: Practical Experiences III (Chair: Dave Thomas)

10:30 *Object-Oriented Design of a Continuos Simulation Software*
D. Mardon, Arcor & A.Y. Le Roux, U. Bordeaux (France)

11:00 *A Tool for Modeling Electromagnetic Devices in Smalltalk-80*
F. Nuwendam, EDF/DER (France)

11:30 *PRAXICOLOR: An Application of Object-Oriented Programming to Colouring Hair Problems*
R. Voyer, Laforia & INT and C. Dujardin, Ackia (France)

12:00 *FANFOO: An Object-Oriented Framework for Event Driven Simulations*
F. Jean, R. Bourgeois & G. Demailly, Thomson CSF (France)

12:30 LUNCH

Session B2: Analysis & Design I (Chair: Rob Murray)

2:00 *The Sequence Software Set - Design and Development of a Large C++ Program*
J.R. George, Jet Propulsion Laboratory (USA)

2:30 *Hierarchy Evolution and the Software Lifecycle*
B. Anderson & S. Gossain, Essex U. (UK)

3:00 *Language Implementation Feedback on Design*
H. Saleh & P. Gautron, Rank Xerox & U. Paris VI (France)

Session B3: Teaching Object-Oriented Methods (Chair: John Potter)

4:00 PANEL: Educators discuss their efforts in introducing the new technology. Panelists will include J. Bezivin (U de Nantes, France), J.C. Boussard (U. de Nice, France), J.F. Perrot (U. Paris VI, France) J. Potter (University of Technology Sydney, Australia).

TRACK C

Session C1: Analysis & Design II (Chair: Georg Heeg)

10:30 *An Application of OSDL*
J. Norgaard, Nokia Telecommunications (Finland)

11:00 Object-Oriented CASE Tool for an Industrial Environment
S.E. Bergner, Objective Systems SF AB (Sweden)

12:00 Multiple and Evolutive Representation in the ROME language.
B. Carre, L. Dekker & J.M.k Geib, U. Lille (France)

12:30 LUNCH

Session C2: Experts Systems (Chair: Jean-Francois Perrot)

2:00 *Knowledge Representation Framework for an Expert System in Network Design*
C. Jouve, ENSM Saint-Etienne (France)

2:30 *An Object-Oriented Knowledge-Based Fault Monitoring System*
D. Porter, Touche Ross Managment Consultants (UK)

3:00 *Ship-Planner: A Conception Support Tool for the Bay Plan Container Ships*
H. Sansen, Sytemia (France)

Session C3: Concurrency & Distribution I (Chair: Pierre America)

4:00 *Decentralized Parsing Method Using Communicating Multiple Concurrent Objects*
C. Numaoka & M. Tokoro, Keio U. (Japan)

4:30 *From Rock-Bottom to Metalevel Actors*
A. Sentini, U. Montreal & S. Giroux, Zuniq Technologies(Canada)

5:00 *Concurrency: An Object-Oriented Approach*
D. Caromel, CRIN-CNRS Nancy (France)

FRIDAY, JUNE 29, 1990

TRACK A

Session A6: Invited Presentation (Chair: Robert Troy)

9:00 **Ada and The Objects**
Ben Brosgol, Alsys (USA)

Session A7: TOOLKITS II (Chair: Michel Habib)

10:30 *HOT: A Generic Hypermedia Toolkit*
N. Guimaracs, AT&T Bell Lab. (USA), INESC Lisbon (Portugal)

11:00 *A C++ Code Browser*
J.R. Glasgow, Yale U. (USA)

11:30 *An Object-Oriented Graphical Toolkit for Prototyping Diagram Editors*
A. Touzani, Y.J. Lee & J.C. Derniame, CRIN Nancy (France)

12:00 *An Extensible Class Library for Geographic Applications*
E. Clementini & P. Di Felice, U. dell'Aquila (Italy)\

12:30 LUNCH

Session A8: User Reports (Chair: Pierre Berger)

2:00 PANEL: Users of Object-Oriented Technology discuss and contrast their experiences

Session A9: TOOLKITS III (Chair: Philippe Gautron)

4:00 *Managing Classes in Very Large Class Repositories*
G.D. Oosthuizen, C. Bekker & C. Avenant, Pretoria U. (South Africa)

4:30 *An Overview of the Mjolner/ORM Environment:*
B. Magnusson, M. Bengtsson, L.O. Dahlin, G. Fries, A. Gustavsson, G. Hedin, S. Minor, D. Oscarsson, M. Taube, Lund U. and Telelogic (Sweden)

5:00 *Flexible Menus*
C. Leung, J. Pugh, D. Cote, R.F. Dillon, & J.W. Tombaugh, Carleton U. (Canada)

TRACK B

Session B4: Analysis & Design III (Chair: Pierre Cointe)

10:30 *Teleogical Maintenance of an Object-Oriented Environment*
V. Karakostas & Z. Palaskas, UMIST (UK)

11:00 *A Method for Object-Oriented Programming: The Class Relationship Method*
P. Desfray, Softeam (France)

11:30 *Essentially Objects*
P.D. Sully, Yourdon International (UK)

12:00 Mecano: a Method for Object-Oriented Software Construction
X. Girod, L.G.I. Gernoble (France)

12:30 LUNCH

Session B5: Databases & Persistence I (Chair: Francois Bancilhon)

2:00 *Persistent Graphical Objects in Procol*
P. van Oosterom & C. Laffra, Leiden U. (The Netherlands)

2:30 *A Practical Approach to Object-Oriented Software Engineering*
J.G.M. van den Goor, Philips Medical (The Netherlands)

3:00 *Persistency and Reusability for the Eiffel Language*
P. Lahire, N. Le Thanh & S. Miranda, U. Nice (France)

Session B6: Databases & Persistence II (Chair: Oscar Nierstrasz)

4:00 *G-Base 4: The New Generation of Object-Oriented Database Management Systems*
R. Roffe, P. Anota & E. Bourgain, Graphael (France)

4:30 *Designing an Object-Oriented Database and DDMS for a CAD System*
S. Hope, P. Fleming & G. Wolff, Wales U. (UK)

5:00 *OODDM: an Object-Oriented Database Design Model*
H. Nguyen & J. Thrasher, Millipore Corp. (USA)

TRACK C

Session C4: Constraints (Chair: Bjorn Freeman-Benson)

10:30 *COOL: An Object System with Constraints*
P. Avesani, A. Perini & F. Ricci, I. per la Ricerca TN (Italy)

11:00 *Creating 3D Scenes with Constraints*
G. Fertey & B. Peroche, ENSM St. Etienne, & J. Zoller, GAMSAU, E.A. Marseille (France)

11:30 *Object-Oriented Design for Modelling Parts, Assemblies and Tolerances*
F. Giacometti & T.C. Chang, Purdue U. (USA)

12:00 Constraint Propagation in an O-O Environment: A Mechanical CAD Experience
K. El Dahshan, U. Compiegne (France)

12:30 LUNCH

Session C5: Concurrency & Distribution II (Chair: Mario Tokoro)

2:00 *Object-Oriented Real-Time Executive*
L. Lamarch & P. Labreche, Objective Systems Quebec (Canada)

2:30 *A Practical Framework for Interactive Application in Guide, an Object-Oriented Distribution System*
V. Normand, Bull-Imag (France)

3:00 *An Extensible Distributed Object Monitoring System, EDOMS*
E.J. Burke, T. Domae & G. Johnson, Northrop Research (USA)

Session C6: Practical Experiences IV (Chair: Wilf Lalonde)

4:00 *Self-explained Toolboxes: a Practical Approach to Reusability*
G. Arango, Altair (France)

4:30 *Jibutsu, Dictionary Objects*
R. Fischer Smoody, Sony (Japan)

5:00 *Towards Music: A description Language for the Muse Object Model*
S. Watari, E-I Osawa, Y. Honda & M. Reeve, Sony (Japan)

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Modular Math

The public-key cryptosystems described in this month's article depend heavily on a branch of number theory known as *modular arithmetic* or *finite math*. A less formal and probably easier-to-visualize.name is *clock arithmetic*.

If you restrict yourself to performing math by moving the hour hand clockwise (for addition) or counterclockwise (for subtraction) around the face of a clock, you're sure to observe some obvious patterns. Most important, no matter how complex the problem, your answer will always be some number in the range of 1 to 12. This is the essence of finite mathematics: You are always working with integers, and you're always working within a finite set. You pick the set's upper limit when you pick the modulus. So, if you pick a modulus of 45, the numbers you can work with are 0, 1, 2, . . ., 44; the smallest is 0, and the largest is the modulus minus 1.

As with the clock, results of addition, subtraction, multiplication, and division "wrap around" so that they always land in the set defined by the modulus. (Although I won't prove it here, I should mention that division in modular arithmetic is defined only when the modulus is prime. The set of numbers chosen when you pick a prime modulus makes up what is referred to as a *Galois field*. There's your party-stopping technical term for this month.) This is nice for cryptography because (1) since the set is finite, you don't have to worry about calculations yielding numbers that grow out of control, and (2) since you're only working with integers, you don't lose any information through round-off errors as you would with floating-point.

The notation you'll often see that indicates modular arithmetic looks like this:

$$10 + 12 = 2 \pmod{10}$$

This indicates that the math was done with modulus 10. You can easily do modular arithmetic on the computer. All it takes is an additional step at the end of each operation: Do the math and then divide the result by the modulus, and the remainder becomes the new result. In BASIC, you use the MOD operator; in C, you use the % operator. Of course, you'll be restricted to the size of the biggest integer your favorite language can handle. (This month's source code comes with a library in 8088 assembly language for performing "unlimited precision" integer arithmetic, as well as some useful subroutines for handling modular arithmetic.)

Transposition Ciphers

So far, I've looked at variations on the substitution cipher theme: Characters in the plaintext are substituted with characters in the ciphertext. An alternative method is to jumble the plaintext according to some algorithm. Such ciphers are referred to as *transposition ciphers*.

First stop—the rail fence cipher, so named for the configuration the letters take as you encrypt the message. It dates back to the Civil War. To encrypt FIFTEEN YEARS AGO, you would write

```
F F E N E R A O
 I T E Y A S G
```

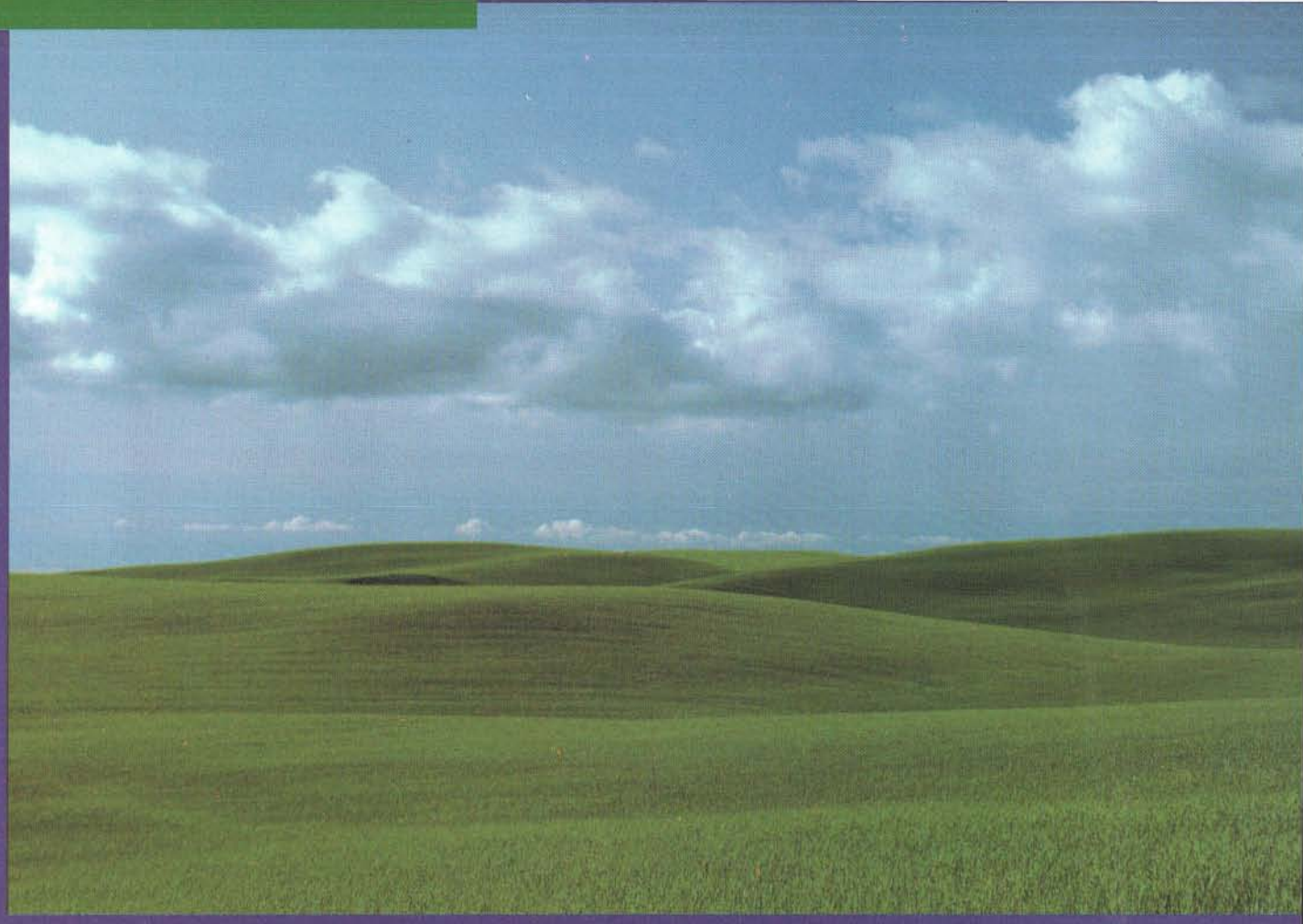
and transmit the message as FFENERAOITEYASG. There are minor variations on this theme, but you get the idea. It probably wouldn't take a serious individual more than a day or so working without a computer to decipher a rail fence–encrypted message, but it kept the codebreakers of its day busy.

The rail fence is a single example from a larger class of encrypting techniques known as *route transposition ciphers*. The varieties of route ciphers are too many to list, but they all use the same principle: Write the message text in a matrix and then copy the characters out while following a predescribed route through the matrix. Here's an example:

```
FIFTE
ENYEA
RSAGO
```

This might be transmitted as FERINSFYATEGEAO (tracing down columns from left to right) or REFSNIAYFGETOAE (tracing up columns from left to right). You might even complicate things further by requiring that a five-digit key be associated with the message. The digits of the key indicate the order in which the columns are selected from the matrix. So, if the key were 32514, the

continued



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transmitted message would be FYAINSEAOFERTEG.

Decrypting a message encoded by a route cipher is usually a matter of running the text through all the possible permutations, guided by knowledge of what the target language looks like. In other words, either some poor human sits at a display, watching the characters being rearranged over and over until something makes sense, or the computer rearranges letters in its head and selects likely successes for human approval.

How does the computer tell when it might have a solution? You have to make it aware of the common two-letter and three-letter tuples (known as *digraphs* and *trigraphs*) that occur in the target language. Frequency tables for these are easily compiled, so the computer can scan each rearrangement of the text and determine the likelihood of a given permutation's being the plaintext message. The computer places its best bets in a file that a human can scan at leisure.

Going Public

Public-key cryptosystems are often referred to as *asymmetric* cryptosystems. Most of the techniques I've described are symmetric: You use only a single key for encrypting and decrypting. Asymmetric systems involve two keys: a public key used by the sender to encrypt the message, and a private key used by the receiver to decrypt the message. As I mentioned earlier, if the bad guys intercept the public key, the security of encrypted messages isn't jeopardized.

The best-known system of this kind is probably the Rivest-Shamir-Adleman system, named after its three creators and referred to hereafter as the RSA algorithm. It works like this: Pick a number N that is the product of two primes (Call them a and b so that $N = a \times b$). Next, pick a number that will become your public key—call it P; it must be less than N. To encrypt a message M, you simply apply the following formula:

$$C = M^{P(\text{mod } N)}$$

where C is the encrypted message. (Notice I'm assuming you can represent your message as a number. This isn't hard—just convert each character to ASCII and handle the message in blocks.)

Decrypting the message uses an identical formula with different factors:

$$M = C^{p(\text{mod } N)}$$

where p is the secret key. The secret key is calculated using the frightful formula

$$P \times p = 1(\text{mod } L)$$

where L is the least common multiple of $(a-1)$ and $(b-1)$. In mathematical terminology, p is the multiplicative inverse of P in the modulus L. (See the text box "Modular Math" on page 316 for some help with this.) Algorithms are available for computing least common multiples and multiplicative inverses in modular arithmetic. They're too gory to go into here, so you'll want to check the bibliography (many good number-theory texts will help as well).

Considerable research has taken place in and around the RSA algorithm. Breaking the system requires the determination of a and b, the factors of N. (Since the sender must know N as well as P, you must assume that N is publicly known.) Once you know a and b, you can easily calculate L. Knowing L and P, you can calculate p, and you can decode the ciphertext. Of course, this boils down to the task of factoring a number into its prime components, an ongoing popular problem in number theory that continues to occupy the minds and computers of mathematicians around the world.

I've seen reports of people running networked Sun workstations for nearly a month to factor 90-digit numbers. It's been shown that, given a careful choice of a and b, as well as a large enough N, decrypting an RSA-enciphered message in any reasonable amount of time will take more computing power than most of us are liable to see (much less own) in the next few years. Unfortunately, this also means that to make the system secure, you've got to perform math on numbers with more digits than most languages on microcomputers are prepared to handle.

Another example of a public-key system is based on the knapsack problem. This problem is easily described: Someone hands you a bag weighing an unknown amount. You're also provided with a pile of various weights, and you've got to pick the subset of those weights that adds up to the exact weight of the bag. This belongs to a class of problems referred to as NP-complete, which is mathematical shorthand for "really tough." Strictly speaking, this means that the time taken by a knapsack-solving algorithm (at least, any algorithm so far discovered) is proportional to some exponential function. As the problem gets bigger—in this case, as you're handed more weights—the time taken to solve it explodes exponentially.

However, you can create an "easy" knapsack. This is a specific instance of

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{
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};
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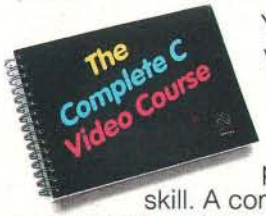

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Listing 1: *Pseudocode for solving an easy knapsack. When the routine terminates, the plaintext will be in M. See the text for the definitions of the other variables.*

```
   i:=N;
   M:=0;
L1:
   IF C'>= s(i) THEN
      BEGIN
         SET BIT i in M;
         C' := C' - s(i);
      END
   i:=i-1;
   IF i>0 THEN GOTO L1;
```

the general knapsack problem that can be rapidly solved—almost by hand. If you can embed your message in an easy knapsack problem (you'll see how in a moment), the trick is then to turn an easy knapsack into a not-so-easy one, transmit the hard knapsack, and provide some means of recovering the easy knapsack. Bad guys would then be faced with having to attack the ciphertext as though it were a general knapsack.

Here's the recipe for a knapsack cryptosystem using the Merkle-Hellman (MH) system. First, you build a sequence of integers such that each member of the sequence is larger than the sum of the preceding members; this is known as a superincreasing series. Let's say that you choose N elements to be in the series. Next, pick a prime number—call it P—larger than the sum of the elements of the superincreasing series, and some random integer M less than P. Now you build your public key, which is actually a series of integers with each element defined as

$$k_i = M \times s_i (\text{mod } P) \quad (i=1,\ldots,N)$$

where s_i is the ith element of the superincreasing series. This series, k_i, is what you give to someone who wants to send you a message—you have to keep the numbers M and P secret. The k_i corresponds to the assorted weights of the knapsack problem I described above.

Encrypting a message is simply a matter of passing through the binary representation of the plaintext adding the k_jth key element to the final encrypted message whenever the jth bit is 1. If you write this out as a formula, it looks like this:

$$C = \sum_{j=1}^{N} k_j \times b_j$$

where b_j represents the jth bit of the unencrypted message, and C represents the ciphertext. As you can see, it helps if the number of integers in the public key is some multiple of 8 so that you can process the message as a string of bytes.

You decrypt the message by first calculating the multiplicative inverse of M in the modulus of P. This lets you transform the encrypted message as follows:

$$C' = C \times m (\text{mod } P)$$

where m is the multiplicative inverse of M (mod P): $M \times m = 1$ (mod P). You can now reconstruct the message by solving the easy knapsack using C'. I've shown the pseudocode for this in listing 1. (Notice that the arrays and bit numbers begin with an index of 1.)

The algorithm in listing 1 solves an easy knapsack problem, which you created when you first picked the superincreasing integers. It is similar to what you have to go through to convert a decimal number into binary. You step down through the powers of 2, testing to see if the number is greater than or equal to the current power. If so, subtract; if not, compare the number with the next lower power of 2 and continue. In fact, the sequence 1,2,4,8,... is one example of a superincreasing sequence.

A big problem with the MH system is that it's...big. Messages are typically expanded when encrypted. Moreover, to be of any practical use, the public key is often larger than the message itself. The MH system's designers originally recommended 100-element key sequences, and it was soon evident that 100 elements might not be enough. As an example, a 200-element key sequence would require 10K bytes of storage.

Another big problem is that the system has come under considerable fire from the cryptographic research community. One of the system's creators actually posted a $1000 reward for the first person to successfully crack the MH system. In 1984, E. F. Brickell won the prize by developing an algorithm that could recover the easy knapsack sequence from the public key and that ran in polynomial time (as opposed to exponential time). Of course, the definition of *secure* depends a lot on how long the secret message must remain secret, how desperate the bad guys are, and what resources they have. Enciphering and deciphering a knapsack is easier than with RSA, so it may be that a well-chosen knapsack cipher would provide sufficient security for noncritical situations.

The DES

I decided not to give much space to the Data Encryption Standard because so

continued

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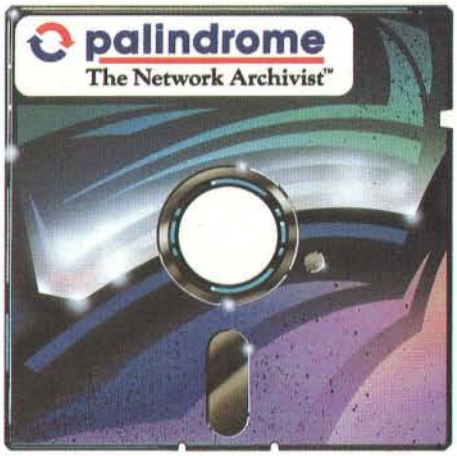

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Listing 2: *The problem. The first 10 people to crack this code will win a mention in BYTE. The first five will win a BYTE sweatshirt.*

```
1636742621202E2C7A30213030791610190467322D2C2F3131313D37396D67223B2522652F3C746D1F282
42A7A0E3C202A383A6C6D20336118101A0062303A48471122353F3B2C2A30362122256F67610D212B2B62
10742423323024286S6E3C2D2C7422243722613726C6E312A3C7423222D2B2E2D2020226234136 3E20202
457431800101B15110400C7D4C5044447672616477 7E4C4D75637C787571545E777D747F786B444471726A
6072744C4D75687A787C75545E767F7370746C4444767 76C6170744C4D726F7D7C7574545E777879767 46
3444476706D6175754C4D746C707876755545E747B7075706B444474716C66707B4C4D75637B7D7676545E
777B7272736244447375 6E66757D4C4D726E7F7C767A545E737978777168444476776D617078 4C4D74627
17F7377545E7179727E796A4444717069 6C72744C4D73687D7C7C7A545E767F7677736E4444777B6F6D72
7F4C4D756A7D767275545E747A777570634444717B6860757B4C4D726B7D767175545E777B787775634 44
471766B677375 4C4D756F797976705 45E717E787071684444717461647 7C4C4D706D7F7C747B545E717D
72777362444476716B677C7E4C4D72687B797074545E767F727F746F444471726D6C727A4C4D726E78797
476545E77774777E76684444777A6B6177744C4D726F7C7B707B545E767875757516C444471706C64707D4C
4D70627A797472545E737C7675736D444476756C61717F4C4D756E7A777D72545E0B226D672F353D6E242
E357431252E34247A273B28203C2636636167153228 3A623179352B6D24292228303E31273D7428283234
203D2C626536363B6B6D611E2E2F6E3820623E3B31404B332E7A2D2B26302024316D2833612E266E232B3
E213728612834 2E69392D232D7431226134202367 6E650A3C26206A3267353220C6E35373B3820 2E612C24
2369282A30793D31774C4D79687D7D714F5361767B75724C507E76707268594F7A7171726F44447672696
072404B75746B7F434F746B62747D4C4D706A7978714F5366747A7676795743 7F77746F6676404B76786A
797F4846866C707579774C507A7873756D594F7973777569444470736A6271404B76777697F7F4848003B3
06A3722613D263A652E3620362C6133283 72C6E312D7936206D252828342E6E312A3027653E3532273C65
6E372B3E3C3172616A6C0867096B58
```

many others already have. In fact, you'll find a good description of it in "Secret Codes" (June 1989 BYTE). It's also easy to acquire source and executable DES encryption programs. Two of the books listed in the bibliography contain the complete source code for DES (Seberry and Pieprzyk in C; Katzan in APL), and I've seen several public domain and shareware versions.

In a nutshell, the DES consists of a series of 18 operations—two permutations and 16 product transformations. The permutations are simply predefined bit shufflings. Each product transformation is a combination of substitution ciphers and transposition ciphers garnished with XOR operations. The system also mixes in a 56-bit key (expanded to 64 bits by adding 8 bits of parity).

The DES was actually submitted by IBM in response to a 1973 request by the National Bureau of Standards for an algorithm that would form the basis for a Federal Information Processing Standard. Among other requirements, the algorithm had to provide a high level of security, be completely specified, and be available to all users and suppliers. It also had to be easy to implement on diverse hardware. Since its acceptance, the DES has been the subject of a remarkable amount of research. Some of the more interesting results include the discovery of "weak" and "semiweak" keys that, when used, actually cause the message to be deciphered if you try to doubly encipher it (as might happen if your department uses a master key to encrypt a library of separately encrypted files).

Due to its widespread acceptance, the DES is probably the encryption method of choice for the majority of situations. It is not, however, a public-key system; parties wishing to communicate under the DES umbrella must find some secure means of transferring the key.

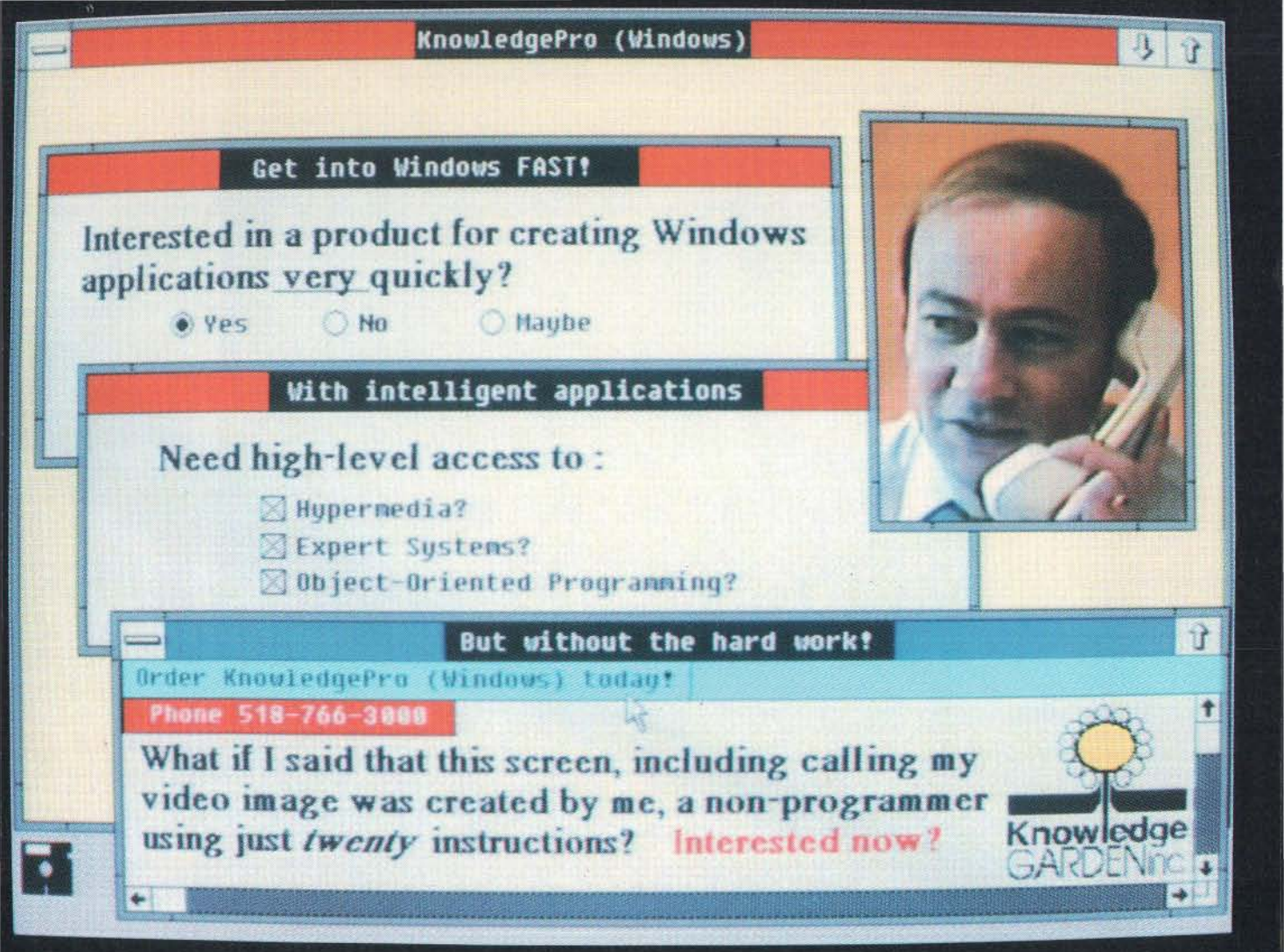
Beale's Treasure

The last cipher I'll present is surrounded by the kind of colorful history that secret codes are supposed to be a part of: buried treasure. It is called the Beale cipher, after Thomas Jefferson Beale. The mechanics of it are absurdly simple, though laborious. Take a famous document—a chapter from the King James Bible, perhaps—and number its words from 1 to whatever. Now scan through your plaintext message, replacing each letter with the number corresponding to a randomly chosen word from the document that begins with that letter. The result is a string of numbers that you can decipher only if you have the key document.

Now for the glamour. The story goes that, in the early 1800s, Beale struck it rich in Colorado. He returned to Virginia and buried the treasure. While rooming at a local hotel, he encrypted three messages using the technique described above and left them with the proprietor. Beale went West again in 1822 and was never heard from again. Unfortunately, the proprietor never received the documents needed to decrypt the messages: He was left with three lists of numbers.

The first message tells (supposedly) where Beale buried his treasure, the second describes the booty, and the third is a list of people who are to share in the treasure. In the early 1880s, 60 years after Beale's disappearance, a gentleman by the name of Ward was able to crack the second message when he discovered that the key document for it was the Declaration of Independence. Apparently,

continued



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that's as far as anyone has gotten—and it's ironic that the message describing the hoard should be the only one so far deciphered. The last time I heard of the Beale messages was about four years ago, and the first and third messages were still a mystery (you can bet no one's spending much time on the third).

I mention this because it seems possible to put together a kind of Beale cipher on microcomputers. The critical ingredient would be a CD-ROM drive and a stack of CD-ROMs of famous documents. With the proliferation of encyclopedias and historical documents on CD-ROM, the available key space—the documents used for encryption—becomes astronomical. Bad guys would have to search through terabytes of information to crack a Beale-ciphered message.

Show Your Stuff

This month, I'd like to end on a different note: It's time for *you* to do a little work. Take a look at listing 2. Looks like a mess, doesn't it? Actually, it is the hexadecimal dump of a message that has been encrypted using two of the techniques I've described this month. The message contains instructions that, if followed precisely, will net you a modest—albeit special—reward.

The first 10 readers who decipher the message and follow its instructions will have their names (and other pertinent information, such as how they went about cracking the puzzle) prominently displayed in an upcoming installment of this column. The first *five* codebreakers will each receive—hold onto your hats—a free BYTE sweatshirt. OK, it's no buried treasure, but at least you don't have to go and dig up the state of Virginia.

So get those late-night codebreaking visors on and warm up your favorite CPU. The source code for the programs that I used to encrypt the message (and which you can use to decrypt it) is available from the usual places. The encrypting process took only seconds on a 16-MHz PS/2 Model 80, so I'm betting that even those of you with 4.77-MHz XTs can—with some wily programming and a little midnight oil—crack the message in just a few weeks. I'll keep the free world posted. ■

Editor's note: *The source code for programs that demonstrate the material in this article is available on disk and on BIX. See page 5 for details.*

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Rick Grehan is the director of the BYTE Lab. He has a B.S. in physics and applied mathematics and an M.S. in computer science/mathematics from Memphis State University. He can be reached on BIX as "rick_g."

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CHAOS MANOR MAIL

Jerry Pournelle answers questions about his column and related computer topics

XCOPY Warning

Dear Jerry,

In your June 1989 column you mentioned a problem with XCOPY in Zenith DOS 3.21. Because both I and the company I work for use it, I had to see what we had. (And yes, I was honest and bought my own copy. I seem to be in the minority with DOS.)

One copy of Zenith DOS had the program you described. My copy, a later copy with the same version number, was dated December 5, 1987.

The programs, however, are the same. You may wish to warn people that *any* XCOPY that is 5402 bytes long is suspect. If you do an ASCII dump of this XCOPY, you'll find no reference to Zenith and a program version number of 1.0. The only reference to ownership is to Microsoft. Did Microsoft include this release of XCOPY in other OEM versions of DOS?

Dave Pearce
Cedar Hill, TX

Yes; the XCOPY that is 5402 bytes long is defective and must not be trusted. Apparently I didn't emphasize that enough. Thank you.—Jerry

Just Another Operating System

Dear Jerry,

I read your column every month, and when it comes to Unix, usually I just tut-tut your misstatements, but in your reply to Tony Dean's letter (September 1989), you said, "Unix remains a guru-friendly system that requires wizardry to get and keep it running. If you have access to a wizard, it's probably wonderful."

Jerry, what has your column been since it began if not a chronicle of the various gurus that you have had in your life, helping you to get and keep running the various computer systems that you have used?

Unix is just another operating system, no worse from a system administration standpoint than any networking operating system, and it provides the tools that I have long wanted to have with other systems. The only differences between Unix and MS-DOS, CP/M, and the other systems (besides its massively increased capability and the number of tools that come as standard equipment) are the names of the gurus.

I don't claim to be a rocket scientist, but I have been successfully administering a six-user Unix system for about nine months without having previously used MS-DOS. I came to it directly from the Apple Sophisticated Operating System environment.

My exposure to MS-DOS (outside of the reading that I've done in BYTE and other PC-oriented magazines) began via VP/ix under Unix. I always feel as if I have cut off three fingers on my right hand whenever I am forced to use MS-DOS now on another machine. I miss background processing, and I especially miss being able to press Alt-function key to open another full-screen window while I'm waiting for something to finish processing.

Any operating system short of Unix on a 386 or better machine is a waste of resources. I just can't see what's keeping you from jumping in with both feet. The water isn't really all that deep.

Tom Betz
Yonkers, NY

Well, you got me there: I could hardly exist without a lot of help. And, of course, my son Alex went off and learned to be a guru.

I don't jump in because I'm still a user, and the applications software isn't there. Sun Microsystems had me tempted for a while, but the folks there never sent the machine that they said would be so easy to use.—Jerry

Large Print On-Screen

Dear Jerry,

I wonder if you might have some quick suggestions for my cousin, who has multiple sclerosis. His eyesight is failing, and he would like to get started in computing. To be able to read comfortably, he needs letters that measure ½-inch square.

My first thought was a Mac with a 19-inch black-and-white monitor. Then I remembered your comments about your eyesight difficulties and solutions. Do you have any suggestions regarding the Mac, the IBM PC, or any other machine that will allow my cousin to learn computing?

He has the financial resources to invest in a good system. His main concern is the size of print that is displayed on the monitor. He needs word processing first and a drawing program second.

Arni Fredrickson
Bothell, WA

The Mac II will certainly do the job, since you can use nearly any typeface you like; several very large monitors are available, including one good one from Apple.

The alternative is a fast 386 VGA system driving a 19-inch Electrohome monitor. I have one of these, and it works fine for me.

The letters in Q&A Write are almost as large as you describe; that's character mode. You could also load Windows and use the graphics-mode editor.

Another large-type word processor program for PCompatibles, called Eye Relief, is available from Skisoft Publishing (1644 Massachusetts Ave., Suite 79-P, Lexington, MA 02173, (800) 662-3622) for $295 plus $4.95 shipping. You can edit text that is up to five times the normal size on the screen.

Neither of the systems will be cheap, although you can put together a good 386 system for less than the equivalent Mac system.

As to whether to steer your cousin toward a Macintosh or a 386 system, I pass. I use a 386 and am about to go to a 486; but I have a Mac available, and I'd hate to have to do without it.—Jerry ■

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. He can be reached c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458, or on BIX as "jerryp."

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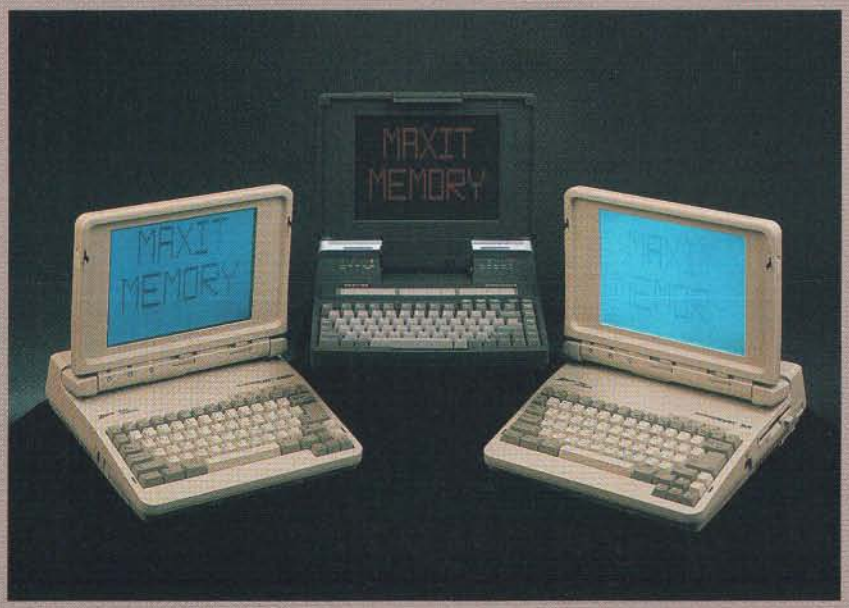

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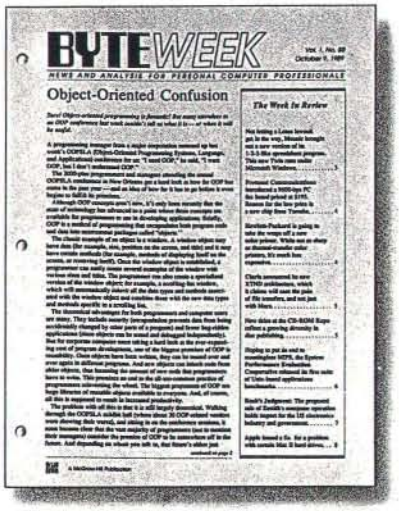
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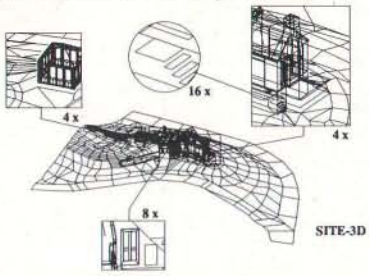

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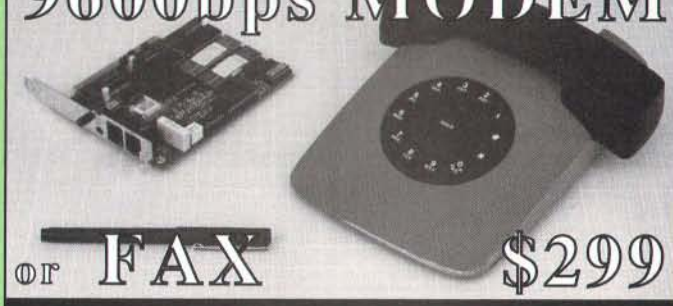

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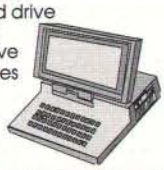

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80287	6MHz	$139.95
80287-8	8MHz	$209.95
80287-10	10MHz	$239.95

80386 Systems

80387-16	16MHz	$349.95
80387-20	20MHz	$399.95
80387-25	25MHz	$499.95
80387-33	33MHz	$649.95

SIP Modules

41256A9A-80	80ns, 256Kx9	$54.95
41256A9A-10	100ns, 256Kx9	$44.95
421000A9A-70	70ns, 1 Mx9	$169.95
421000A9A-80	80ns, 1 Mx9	$124.95
421000A9A-10	100ns, 1 Mx9	$116.95
94000L-80	80ns, 4 Mx9	$499.95
94000L-10	100ns, 4 Mx9	$499.95

SIMM Modules

41256A9B-80	80ns, 256Kx9	$49.95
41256A9B-10	100ns, 256Kx9	$39.95
421000A8B-10	100ns, 1 Mx8	$109.95
421000A9B-70	70ns, 1 Mx9	$169.95
421000A9B-80	80ns, 1 Mx9	$119.95
421000A9B-10	100ns, 1 Mx9	$113.95
94000S-80	80ns, 4 Mx9	$499.95
94000S-10	100ns, 4 Mx9	$499.95

NEC V20 & V30 Chips

UPD70108-5	5MHz, V20 Chip	$5.25
UPD70108-8	8MHz, V20 Chip	$6.95
UPD70108-10	10MHz, V20 Chip	$10.95
UPD70116-8	8MHz, V30 Chip	$7.95
UPD70116-10	10MHz, V30 Chip	$13.49

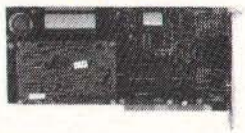
Dynamic RAMs

TMS4416-12	120ns, 16Kx4	$2.75
TMS4416-15	150ns, 16Kx4	$2.49
4116-12	120ns, 16Kx1	$1.49
4116-15	150ns, 16Kx1	$1.09
4116-20	200ns, 16Kx1	$.89
4164-100	100ns, 64Kx1	$2.75
4164-120	120ns, 64Kx1	$2.39
4164-150	150ns, 64Kx1	$2.15
4164-200	200ns, 64Kx1	$1.75
41256-60	60ns, 256Kx1	$5.25
41256-80	80ns, 256Kx1	$3.75
41256-100	100ns, 256Kx1	$3.15
41256-120	120ns, 256Kx1	$2.95
41256-150	150ns, 256Kx1	$2.59
41464-80	80ns, 64Kx4	$5.95
41464-10	100ns, 64Kx4	$4.95
41464-12	120ns, 64Kx4	$3.95
41464-15	150ns, 64Kx4	$3.59
511000P-70	70ns, 1 Mx1	$13.95
511000P-80	80ns, 1 Mx1	$12.95
511000P-10	100ns, 1 Mx1	$12.35
514256P-80	80ns, 256Kx4	$13.45
514256P-10	100ns, 256Kx4	$12.95

Static RAMs

6116P-3	150ns, 16Kx 1(CMOS)	$2.79
6264LP-10	100ns, 64Kx1 (CMOS)	$6.95
6264LP-15	150ns, 64Kx1 (CMOS)	$4.95
43256-10L	100ns, 256Kx1	$10.95
43256-15L	150ns, 256Kx1	$9.95
62256LP-15	150ns, 256Kx1 (CMOS)	$10.95

Niche Tek 9600 Baud FAX Board



- 9600 Baud Communication Rate
- Unit will turn the computer on, send or receive FAX, then turn off
- Features: Multiple Telephone Directory, Scheduling System and Transaction Log

FAX96.....$299.95

Jameco 8MB EMS RAM Expansion Card

• IBM AT/286 and compatible computers • Capable of operating at a bus speed of 12MHz • Expandable up to 8MB using 1MB SIMM modules in increments of 2MB (zero-MB on-board) • Selectable configuration

JE1084.....$199.95

Sony 3.5" 720KB Disk Drive

- IBM PC/XT/AT Compatible
- Double-sided, double-density
- Documentation included

MPF11 Disk Drive $69.95

SMK 5.25" Installation Kit for MPF11.... $14.95

A.R.T. EPROM Programmer

• Programs all current EPROMs in the 2716 to 27512 range plus the X2864 EEPROM • RS232 port for connection to computer (required) • Software included

EPP.....$179.95

Metex Digital Multimeters

General Specs:
- Handheld, high accuracy • AC/DC voltage, AC/DC current, resistance, diodes, continuity, transistor hFE
- Manual ranging w/ overload protection

M3650, 3650B & M4650 only:
• Also measure frequency and capacitance

M4650 only: • Data hold switch • 4.5 digit

M3610	3.5 Digit Multimeter	$49.95
M3650	3.5 Digit Multimeter w/Frequency & Capacitance	$69.95
M3650B	Same as M3650 w/Bargraph	$74.95
M4650	4.5 Digit w/Frequency, Capacitance and Data Hold Switch	$99.95

Jameco 12MHz 80286 Desktop Computer Kit

- Fully IBM AT Compatible
- Free! DR DOS (Disk Operating System) Software Included
- Free! QAPLUS Diagnostic Software Included!
- Free! WORDSTAR EASY Word Processing Software Included!
- 512KB RAM Included, Expandable to 4MB on board
- 8/12MHz Keyboard Switchable Operation
- AMI BIOS ROMs Included
- Fliptop Case w/200 Watt Power Supply
- Teac 5.25" 1.2MB DSHD Disk Drive
- Parallel Printer Port, Serial (RS232) Port, Game Port
- Fujitsu 101-Key (Enhanced) Keyboard

Shown with EGA Option (not included) JE1059 EGA Monitor and EGA Card....$459 (See Right)

JE3008 12MHz 80286 Compatible Kit.....$599.95

Seikosha Printers

SEIKOSHA
A SEIKO GROUP COMPANY

9-Pin IBM Compatible Printer

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24-Pin High-Quality IBM Compatible Printer

SL90 ..... $329.95

24-Pin Multi-Font Wide Carriage IBM Compatible Printer

SL230 ..... $499.95

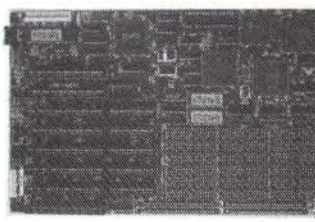
9-Pin High Speed Wide Carriage Black & White / Color IBM Compatible Printer

SK3005 ..... $469.95

SCK2 Optional Kit allows Color Printing on the SK3005 ..... $149.95

SL90

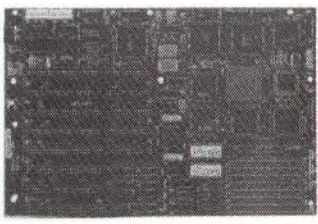
Jameco 16MHz 80286 Motherboard



- Baby size motherboard
- Expandable to 1MB RAM using 256KB DRAM chips or 4MB using 1MB DRAM chips
- Additional 1MB with 256KB DRAM SIPs or 4MB with 1MB DRAM SIPs for a total of 8MB
- Uses 100ns DRAMs
- 8/16MHz hardware or keyboard selectable operation
- AMI BIOS ROMs included
- 16MHz CMOS Harris CPU
- Supports all NEAT® CHIPSet™ functions including shadow RAM, LIM EMS 4.0 RAM, re-mapping, selectable wait states, memory interleaving, etc...
- Battery-backed clock/calendar
- Five 16-bit and three 8-bit expansion bus slots
- Size: 13" x 8.5"

JE3010.....$299.95

Jameco 20MHz 80386 Motherboard



- Baby size motherboard
- Expandable to 2MB RAM using 256KB SIPs, 8MB using 1MB SIPs or 16MB using the optional JE3530 memory card (Please note the minimum RAM expansion is 4 SIP Modules at a time)
- Uses 100ns SIPs
- Includes battery pack
- 8/20MHz keyboard selectable operation
- AMI BIOS ROMs included
- Shadow RAM for fast BIOS and video performance
- Adjustable bus speeds and wait states
- 8 expansion slots - one 32-bit (for optional memory card), five 16-bit, and two 8-bit
- Size: 13" x 8.5"

JE3520 20MHz 386 Baby Motherboard.....$629.95

JE3530 8MB 32-bit Plug-in Memory Card for JE3520 (Zero MB RAM) $129.9

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Jameco 20MHz 80386 Desktop Computer Kit

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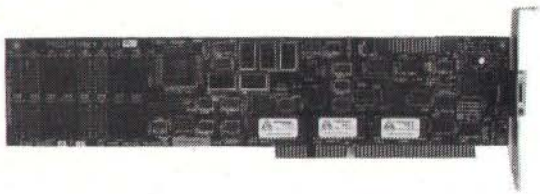
Free! QAPLUS Diagnostic Software Included!
Free! WORDSTAR EASY Word Processing Software Included!
1MB RAM Included, Expandable to 8MB on board, 16MB with optional expansion board
8/16/20MHz Keyboard Switchable Operation
AMI BIOS ROMs Included
Fliptop Case w/200 Watt Power Supply
MiniScribe 3.5" 40MB RLL Hard Disk Drive
Teac 1.2MB Floppy DSHD Disk Drive
Fujitsu 101-Key (Enhanced) Keyboard

Shown with VGA Option (not included) JE2059 Multiscan Monitor and VGA Card....**$669.90** (See Below)

E3550 20MHz 80386 Compatible Kit.....**$1599.95**

ameco IBM C/XT/AT ompatible ards



JE1057

E1043	360KB/720KB/1.2MB/1.44MB Floppy Disk Controller Card (PC/XT/AT)	$49.95
E1050	Monochrome Graphics Card w/Parallel Printer Port (PC/XT/AT)	$49.95
E1052	Color Graphics Card w/ Parallel Printer Port (PC/XT/AT)	$49.95
E1055	EGA Card w/ 256KB Video RAM (PC/XT/AT)	$139.95
E1057	8/16-Bit VGA Card w/ 256KB Video RAM (PC/XT/AT)	$199.95
E1060	I/O Card w/ Serial, Game, Printer Port & Real Time Clock (PC/XT)	$59.95
E1062	RS232 Serial Half Card (PC/XT/AT)	$29.95
E1065	I/O Card w/ Serial, Game and Parallel Printer Port (AT)	$59.95
E1077	Multi I/O Card w/ 360KB/720KB/1.2MB/1.44MB Floppy Controller (AT)	$99.95

GA, VGA & Multiscan Monitor Packages

elisys 14" EGA monitor and EGA card package
20 x 350 max. resolution)
E1059 EGA Monitor & EGA Card.....**$459.95**

JE2061

elisys 14" Multiscan monitor and 16-Bit VGA card ackage (800 x 600 max. resolution)
E2059 Multiscan Monitor & VGA Card.....**$669.90**

elisys 14" VGA monitor and 16-Bit VGA card package
20 x 480 max. resolution)
E2061 VGA Monitor & VGA Card.....**$599.90**

IBM PC/XT/AT Compatible Keyboards

FKB4700

E2015 84-Key Standard AT Style Layout **$59.95**
KB4700 101-Key Enhanced Layout with 12 Function Keys **$69.95**

MEI 100-Key Microtype Keyboard

- IBM PC/XT/AT/386 Compatible
- Saves an amazing 60% of the desk space used by equivalent standard keyboards

MIRU.....**$129.95**

Jameco Digitizer Tablet

- AutoCAD 10 template and four-button puck • Resolution: up to 1016 lines per inch • Accuracy: ±.025" • Emulates three of the worlds most popular formats: Summagraphics MM, Summagraphics Bit Pad One, Calcomp 2000 • EEPROM allows custom configuration

JCAD Digitizer Tablet **$199.95**
Stylus Two Button Stylus **$39.95**

Logitech ScanMan Plus Scanner

- IBM PC/XT/AT Compatible
- 4" Scanning Window
- 400 dpi

SCANP.....**$219.95**

Logitech Mice

MSER Serial Mouse & MouseWare Software **$89.95**
MBUS Mouse w/Bus Board & MouseWare Software **$99.95**
MPS2 PS/2 Mouse & MouseWare Software **$79.95**

Modems

9600E Pictured

External Modems

1200C	Datatronics 1200 Baud	$89.95
2400C	Datatronics 2400 Baud	$149.95
9600E	Prometheus 9600 Baud	$699.95

Internal Modems

1200B	Jameco 1200 Baud	$49.95
2400B	Jameco 2400 Baud	$99.95

Modems listed above Include ProComm Software

IBM Compatible Cases and Power Supplies

JE1030

JE2012

JE1010	Flip-Top Standard PC/XT Case	$39.95
JE1011	Side Standard PC/XT Case	$39.95
JE1030	150 watt PC/XT Power Supply	$59.95
JE1032	200 watt Baby AT Power Supply	$89.95
JE1035	300 watt AT Power Supply	$139.95
JE2011	Vertical Case w/300W Pwr. Supply	$249.95
JE2012	Mini-Vertical Case w/200W Pwr. Supply	$149.95
JE2019	Flip-Top Baby AT Case	$69.95

Floppy Disk Drives

Mitsubishi
MF353B 3.5" 720KB Internal Drive **$99.95**
Toshiba
356KU 3.5" 1.44MB Internal Drive .. **$109.95**
Teac
FD55B 5.25" 360KB Half Ht. **$89.95**
FD55G 5.25" 1.2MB Half Ht. **$99.95**

MiniScribe Hard Drives

MFM

M8425	20MB (68ms) 3.5"HH	$224.95
M8425XT	20MB (68ms) 3.5"HH (Kit)	$269.95
M8425AT	20MB (68ms) 3.5"HH (Kit)	$339.95

RLL

M8438	30MB (68ms) 3.5"HH	$249.95
M8438XT	30MB (68ms) 3.5"HH (Kit)	$299.95
M8438AT	30MB (68ms) 3.5"HH (Kit)	$389.95
M8450	40MB (46ms) 3.5"HH	$329.95
M8450XT	40MB (46ms) 3.5"HH (Kit)	$369.95
M8450AT	40MB (46ms) 3.5"HH (Kit)	$429.95

(Kit) includes Hard Disk Drive, Controller & Cables

Colorado Memory Systems 40MB Tape Back-Up

- IBM PC/XT/AT/386 Compatible • Back-up 40MB in 40 minutes • Back-up 60 to 120MB with extended tapes and data compression software • Includes 40MB tape cartridge

DJ10	40MB Tape Back-Up	$299.95
KE10	External Enclosure Kit	$149.95
TB40	40MB Tape Cartridge	$24.95
TB60	60MB Tape Cartridge	$32.95

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Less Monitor	14" AMBER	14" 4-Color	14" 16-Color	12" White	14" VGA	14" XVGA
CGA	W/ Tilt	W/ Tilt	W/ Tilt	VGA	256 ——	Colors
MGA	MGA	CGA	EGA	W/ Tilt	W/ Tilt	W/ Tilt
Card	720x348	640x200	640x350	640x480	800x600	1024x768
Included	.31 Dot Pt	.51 Dot Pt	.31 Dot Pt	16 Bit	16 Bit	16 Bit
				256K	256K	512K

EXCEL *Personal Computers*

Less Monitor	14" AMBER	14" 4-Color	14" 16-Color	12" White	14" VGA	14"
CGA	W/ Tilt	W/ Tilt	W/ Tilt	VGA	256 ——	
MGA	MGA	CGA	EGA	W/ Tilt	W/ Tilt	
Card	720x348	640x200	640x350	640x480	800x600	1
Included	.31 Dot Pt	.51 Dot Pt	.31 Dot Pt	16 Bit	16 Bit	
				256K	256K	

	MODEL/DESCRIPTION	BASE	MONO	CGA	EGA	MONO VGA	COLOR VGA	VGA SYNC
88-12	1 / (1) 360K Floppy Drive	**$399**	**$499**	**$619**	**$808**	**$577**	**$899**	**$998**
640K	2 / (2) 360K Floppy Drives	$469	$569	$689	$878	$689	$969	$1,068
12 MHZ	20 / 22MB,45MILS,MFM,3.5"	$649	$749	$869	$1,058	$869	$1,149	$1,248
	30 / 33MB, 45MILS, RLL, 3.5"	$679	$779	$899	$1,088	$899	$1,179	$1,278
286-XT	1 / (1) 360K Floppy Drive	**$499**	**$599**	**$719**	**$908**	**$719**	**$999**	**$1,098**
1 MB RAM	2 / (2) 360K Floppy Drives	$569	$669	$789	$978	$789	$1,069	$1,168
10 MHZ	20 / 22MB,45MILS,MFM,3.5"	$749	$849	$969	$1,158	$969	$1,249	$1,348
	30 / 33MB, 45MILS, RLL, 3.5"	$779	$879	$999	$1,188	$999	$1,279	$1,378
286-12	1 / (1) 1.2MB Floppy Drive	**$699**	**$799**	**$919**	**$1,131**	**$885**	**$1,199**	**$1,325**
1 MB RAM	20 / 45MILS,MFM,1-1,KL320	$899	$999	$1,119	$1,331	$1,085	$1,399	$1,525
12.5 MHZ	20 / 38MILS,MFM,1-1,ST125	$979	$1,079	$1,199	$1,411	$1,165	$1,479	$1,605
0-WAIT	30 / 38MILS,MFM,1-1,ST138	$1,039	$1,139	$1,259	$1,471	$1,225	$1,539	$1,665
Norton SI-14	40 / 60MILS,IDE,1-1,WD	$1,029	$1,129	$1,249	$1,461	$1,215	$1,529	$1,655
Speed-16Mhz	40 / 38MILS,RLL,1-1,MS8450	$1,079	$1,179	$1,299	$1,511	$1,265	$1,579	$1,705
Exp. to 4MB	40 / 20MILS,IDE,1-1,CONNERS	$1,099	$1,199	$1,319	$1,531	$1,285	$1,599	$1,725
AWARD BIOS	65 / 38MILS,RLL,1-1,PTI	$1,119	$1,219	$1,339	$1,551	$1,305	$1,619	$1,745
DIP DRAM	85 / 20MILS,IDE,1-1,CONNERS	$1,269	$1,369	$1,489	$1,701	$1,455	$1,769	$1,895
EMS 4.0	120 / 20MILS,IDE,1-1,CONNER	$1,509	$1,609	$1,729	$1,941	$1,695	$2,009	$2,135
	200 / 16MILS,IDE,1-1,CONNER	$2,179	$2,279	$2,399	$2,611	$2,365	$2,679	$2,805
	320 / 16MILS,ESDI,1-1CDC	$2,979	$3,079	$3,199	$3,411	$3,165	$3,479	$3,605
286-16	1 / (1) 1.2MB Floppy Drive	**$799**	**$899**	**$1,019**	**$1,231**	**$985**	**$1,299**	**$1,425**
1 MB RAM	20 / 45MILS,MFM,1-1,KL320	$1,019	$1,119	$1,239	$1,451	$1,205	$1,519	$1,645
16 MHZ	20 / 38MILS,MFM,1-1,ST125	$1,069	$1,169	$1,289	$1,501	$1,255	$1,569	$1,695
0-WAIT	30 / 38MILS,MFM,1-1,ST138	$1,139	$1,239	$1,359	$1,571	$1,325	$1,639	$1,765
Norton SI-18	40 / 60MILS,IDE,1-1,WD	$1,129	$1,229	$1,349	$1,561	$1,315	$1,629	$1,755
Speed-22Mhz	40 / 38MILS,RLL,1-1,MS8450	$1,169	$1,269	$1,389	$1,601	$1,355	$1,669	$1,795
Exp. to 4MB	40 / 20MILS,IDE,1-1,CONNERS	$1,189	$1,289	$1,409	$1,621	$1,375	$1,689	$1,815
AMI BIOS	65 / 38MILS,RLL,1-1,PTI	$1,209	$1,309	$1,429	$1,641	$1,395	$1,709	$1,835
SIM Modules	85 / 20MILS,IDE,1-1,CONNERS	$1,359	$1,459	$1,579	$1,791	$1,545	$1,859	$1,985
	120 / 20MILS,IDE,1-1,CONNER	$1,599	$1,699	$1,819	$2,031	$1,785	$2,099	$2,225
	200 / 16MILS,IDE,1-1,CONNER	$2,269	$2,369	$2,489	$2,701	$2,455	$2,769	$2,895
	320 / 16MILS,ESDI,1-1,CDC	$3,079	$3,179	$3,299	$3,511	$3,265	$3,579	$3,705
286-20	1 / (1) 1.2MB Floppy Drive	**$899**	**$999**	**$1,119**	**$1,331**	**$1,085**	**$1,399**	**$1,525**
1 MB RAM	20 / 45MILS,MFM,1-1,KL320	$1,119	$1,219	$1,339	$1,551	$1,305	$1,619	$1,745
20 MHZ	20 / 38MILS,MFM,1-1,ST125	$1,169	$1,269	$1,389	$1,601	$1,355	$1,669	$1,795
0-WAIT	30 / 38MILS,MFM,1-1,ST138	$1,239	$1,339	$1,459	$1,671	$1,425	$1,739	$1,865
Norton SI-22.5	40 / 60MILS,IDE,1-1,WD	$1,229	$1,329	$1,449	$1,661	$1,415	$1,729	$1,855
Speed-24 Mhz	40 / 38MILS,RLL,1-1,MS8450	$1,269	$1,369	$1,489	$1,701	$1,455	$1,769	$1,895
Exp. to 4MB	40 / 20MILS,IDE,1-1,CONNERS	$1,289	$1,389	$1,509	$1,721	$1,475	$1,789	$1,915
AMI BIOS	65 / 38MILS,RLL,1-1,PTI	$1,309	$1,409	$1,529	$1,741	$1,495	$1,809	$1,935
DIP DRAM	85 / 20MILS,IDE,1-1,CONNERS	$1,459	$1,559	$1,679	$1,891	$1,645	$1,959	$2,085
EMS 4.0	120 / 20MILS,IDE,1-1,CONNER	$1,699	$1,799	$1,919	$2,131	$1,885	$2,199	$2,325
Shadow RAM	200 / 16MILS,IDE,1-1,CONNER	$2,369	$2,469	$2,589	$2,801	$2,555	$2,869	$2,995
	320 / 16MILS,ESDI,1-1,CDC	$3,179	$3,279	$3,399	$3,611	$3,365	$3,679	$3,805
386SX	1 / (1) 1.2MB Floppy Drive	**$999**	**$1,099**	**$1,219**	**$1,431**	**$1,185**	**$1,499**	**$1,625**
1 MB RAM	20 / 45MILS,MFM,1-1,KL320	$1,219	$1,319	$1,439	$1,651	$1,405	$1,719	$1,845
16 MHZ	20 / 38MILS,MFM,1-1,ST125	$1,269	$1,369	$1,489	$1,701	$1,455	$1,769	$1,895
0-WAIT	30 / 38MILS,MFM,1-1,ST138	$1,339	$1,439	$1,559	$1,771	$1,525	$1,839	$1,965
Norton SI-22.5	40 / 60MILS,IDE,1-1,WD	$1,329	$1,429	$1,549	$1,761	$1,515	$1,829	$1,955
Speed-25 Mhz	40 / 38MILS,RLL,1-1,MS8450	$1,369	$1,469	$1,589	$1,801	$1,555	$1,869	$1,995
Exp. to 8MB	40 / 20MILS,IDE,1-1,CONNERS	$1,389	$1,489	$1,609	$1,821	$1,575	$1,889	$2,015
AMI BIOS	65 / 38MILS,RLL,1-1,PTI	$1,409	$1,509	$1,629	$1,841	$1,595	$1,909	$2,035
SIPP Modules	85 / 20MILS,IDE,1-1,CONNERS	$1,559	$1,659	$1,779	$1,991	$1,745	$2,059	$2,185
EMS 4.0	120 / 20MILS,IDE,1-1,CONNER	$1,799	$1,899	$2,019	$2,231	$1,985	$2,299	$2,425
Shadow RAM	200 / 16MILS,IDE,1-1,CONNER	$2,469	$2,569	$2,689	$2,901	$2,655	$2,969	$3,095
	320 / 16MILS,ESDI,1-1,CDC	$3,279	$3,379	$3,499	$3,711	$3,465	$3,779	$3,905

	MODEL/DESCRIPTION	BASE	MONO	CGA	EGA	MONO VGA	COLOR VGA
386-20	1 / (1) 1.2MB Floppy Drive	**$1,299**	**$1,399**	**$1,519**	**$1,731**	**$1,485**	**$1,799**
1 MB RAM	20 / 45MILS,MFM,1-1,KL320	$1,529	$1,629	$1,749	$1,961	$1,715	$2,029
20 MHZ	20 / 38MILS,MFM,1-1,ST125	$1,579	$1,679	$1,799	$2,011	$1,765	$2,079
0-WAIT	30 / 38MILS,MFM,1-1,ST138	$1,649	$1,749	$1,869	$2,081	$1,835	$2,149
Norton SI-22.5	40 / 60MILS,IDE,1-1,WD	$1,639	$1,739	$1,859	$2,071	$1,825	$2,139
Speed-24 Mhz	40 / 38MILS,RLL,1-1,MS8450	$1,689	$1,789	$1,909	$2,121	$1,875	$2,189
Exp. to 8MB	40 / 20MILS,IDE,1-1,CONNERS	$1,709	$1,809	$1,929	$2,141	$1,895	$2,209
AMI BIOS	65 / 38MILS,RLL,1-1,PTI	$1,719	$1,819	$1,939	$2,151	$1,905	$2,219
SIPP Modules	85 / 20MILS,IDE,1-1,CONNERS	$1,869	$1,969	$2,089	$2,301	$2,055	$2,369
EMS 4.0	120 / 20MILS,IDE,1-1,CONNER	$2,109	$2,209	$2,329	$2,541	$2,295	$2,609
Shadow RAM	200 / 16MILS,IDE,1-1,CONNER	$2,779	$2,879	$2,999	$3,211	$2,965	$3,279
	320 / 16MILS,ESDI,1-1,CDC	$3,589	$3,689	$3,809	$4,021	$3,775	$4,089
386-25	1 / (1) 1.2MB Floppy Drive	**$1,499**	**$1,599**	**$1,719**	**$1,931**	**$1,685**	**$1,999**
2 MB RAM	20 / 38MILS,MFM,1-1,ST125	$1,779	$1,879	$1,999	$2,211	$1,965	$2,279
25 MHZ	30 / 38MILS,MFM,1-1,ST138	$1,849	$1,949	$2,069	$2,281	$2,035	$2,349
0-WAIT	40 / 60MILS,IDE,1-1,WD	$1,839	$1,939	$2,059	$2,271	$2,025	$2,339
Norton SI-27	40 / 38MILS,RLL,1-1,MS8450	$1,889	$1,989	$2,109	$2,321	$2,075	$2,389
Speed-36 Mhz	40 / 20MILS,IDE,1-1,CONNERS	$1,909	$2,009	$2,129	$2,341	$2,095	$2,409
Exp. to 8MB	65 / 38MILS,RLL,1-1,PTI	$1,919	$2,019	$2,139	$2,351	$2,105	$2,419
AMI BIOS	85 / 20MILS,IDE,1-1,CONNERS	$2,069	$2,169	$2,289	$2,501	$2,255	$2,569
SIPP Modules	120 / 20MILS,IDE,1-1,CONNER	$2,309	$2,409	$2,529	$2,741	$2,495	$2,809
EMS 4.0	200 / 16MILS,IDE,1-1,CONNER	$2,979	$3,079	$3,199	$3,411	$3,165	$3,479
Shadow RAM	320 / 16MILS,ESDI,1-1,CDC	$3,789	$3,889	$4,009	$4,221	$3,975	$4,289
386-25	1 / (1) 1.2MB Floppy Drive	**$1,769**	**$1,869**	**$1,989**	**$2,201**	**$1,955**	**$2,269**
4 MB RAM	20 / 38MILS,MFM,1-1,ST125	$2,039	$2,139	$2,259	$2,471	$2,225	$2,539
25 MHZ	30 / 38MILS,MFM,1-1,ST138	$2,099	$2,199	$2,319	$2,531	$2,285	$2,599
0-WAIT	40 / 60MILS,IDE,1-1,WD	$2,089	$2,189	$2,309	$2,521	$2,275	$2,589
Norton SI-36	40 / 38MILS,RLL,1-1,MS8450	$2,139	$2,239	$2,359	$2,571	$2,325	$2,639
Speed-44 Mhz	40 / 20MILS,IDE,1-1,CONNERS	$2,159	$2,259	$2,379	$2,591	$2,345	$2,659
Exp. to 16MB	65 / 38MILS,RLL,1-1,PTI	$2,179	$2,279	$2,399	$2,611	$2,365	$2,679
AMI BIOS	85 / 20MILS,IDE,1-1,CONNERS	$2,319	$2,419	$2,539	$2,751	$2,505	$2,819
SIMM	120 / 20MILS,IDE,1-1,CONNER	$2,569	$2,669	$2,789	$3,001	$2,755	$3,069
EMS 4.0	200 / 16MILS,IDE,1-1,CONNER	$3,229	$3,329	$3,449	$3,661	$3,415	$3,729
32K CACHE	320 / 16MILS,ESDI,1-1,CDC	$4,039	$4,139	$4,259	$4,471	$4,225	$4,539
386-33	1 / (1) 1.2MB Floppy Drive	**$2,719**	**$2,819**	**$2,939**	**$3,151**	**$2,905**	**$3,219**
4 MB RAM	20 / 38MILS,MFM,1-1,ST125	$2,989	$3,089	$3,209	$3,421	$3,175	$3,489
33 MHZ	30 / 38MILS,MFM,1-1,ST138	$3,049	$3,149	$3,269	$3,481	$3,235	$3,549
0-WAIT	40 / 60MILS,IDE,1-1,WD	$3,039	$3,139	$3,259	$3,471	$3,225	$3,539
Norton SI-44	40 / 38MILS,RLL,1-1,MS8450	$3,089	$3,189	$3,309	$3,521	$3,275	$3,589
Speed-58 Mhz	40 / 20MILS,IDE,1-1,CONNERS	$3,109	$3,209	$3,329	$3,541	$3,295	$3,609
Exp. to 8MB	65 / 38MILS,RLL,1-1,PTI	$3,129	$3,229	$3,349	$3,561	$3,315	$3,629
AMI BIOS	85 / 20MILS,IDE,1-1,CONNERS	$3,269	$3,369	$3,489	$3,701	$3,455	$3,769
SIMM	120 / 20MILS,IDE,1-1,CONNER	$3,519	$3,619	$3,739	$3,951	$3,705	$4,019
EMS 4.0	200 / 16MILS,IDE,1-1,CONNER	$4,179	$4,279	$4,399	$4,611	$4,365	$4,679
64K CACHE	320 / 16MILS,ESDI,1-1,CDC	$4,989	$5,089	$5,209	$5,421	$5,175	$5,489
486-25	1 / (1) 1.2MB Floppy Drive	**$4,619**	**$4,719**	**$4,839**	**$5,051**	**$4,805**	**$5,119**
8 MB RAM	20 / 38MILS,MFM,1-1,ST125	$4,889	$4,989	$5,109	$5,321	$5,075	$5,389
25 MHZ	30 / 38MILS,MFM,1-1,ST138	$4,949	$5,049	$5,169	$5,381	$5,135	$5,449
0-WAIT	40 / 60MILS,IDE,1-1,WD	$4,939	$5,039	$5,159	$5,371	$5,125	$5,439
Norton SI-44	40 / 38MILS,RLL,1-1,MS8450	$4,989	$5,089	$5,209	$5,421	$5,175	$5,489
Speed-117 Mhz	40 / 20MILS,IDE,1-1,CONNERS	$5,009	$5,109	$5,229	$5,441	$5,195	$5,509
Exp. to 16MB	65 / 38MILS,RLL,1-1,PTI	$5,029	$5,129	$5,249	$5,461	$5,215	$5,529
AWARD BIOS	85 / 20MILS,IDE,1-1,CONNERS	$5,169	$5,269	$5,389	$5,601	$5,355	$5,669
DIP	120 / 20MILS,IDE,1-1,CONNER	$5,419	$5,519	$5,639	$5,851	$5,605	$5,919
EMS 4.0	200 / 16MILS,IDE,1-1,CONNER	$6,079	$6,179	$6,299	$6,511	$6,265	$6,579
	320 / 16MILS,ESDI,1-1,CDC	$6,889	$6,989	$7,109	$7,321	$7,075	$7,389

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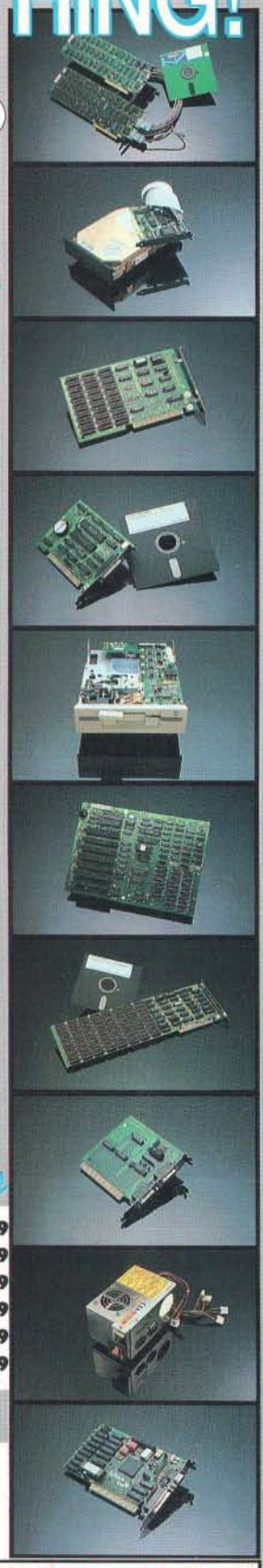

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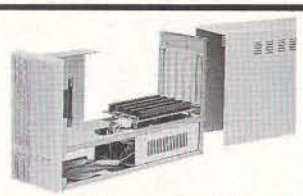

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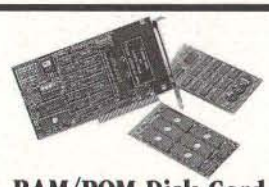

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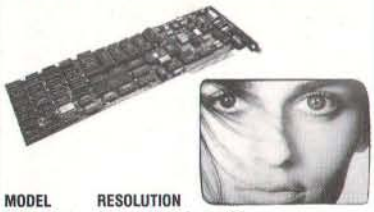

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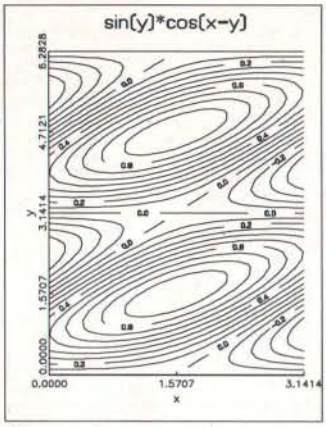

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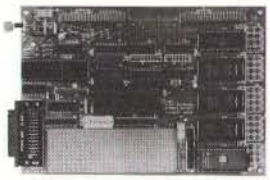

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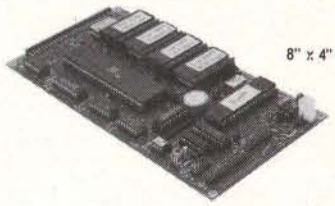

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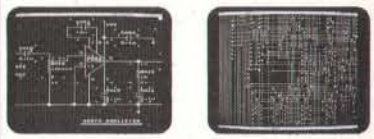

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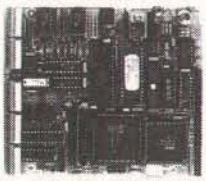

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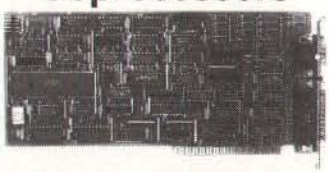

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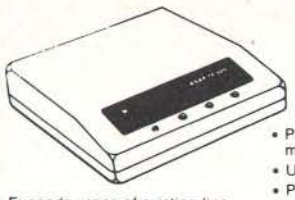

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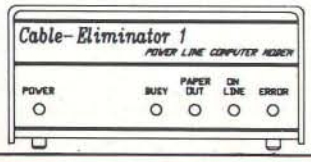

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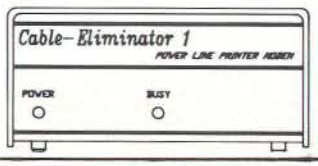

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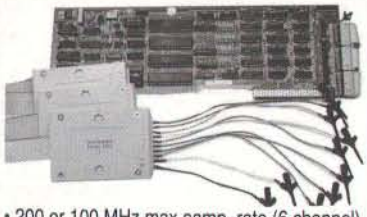

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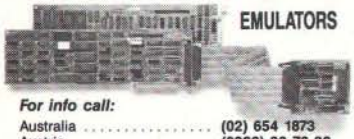

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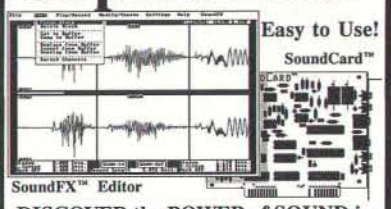

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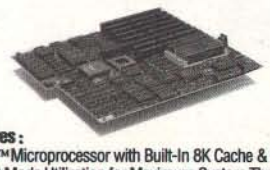

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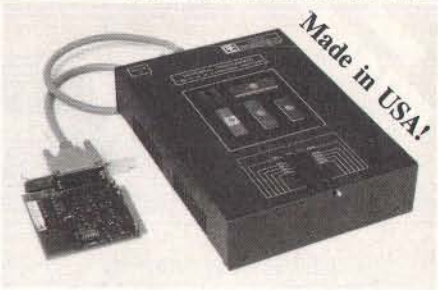

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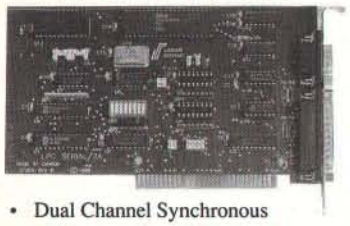

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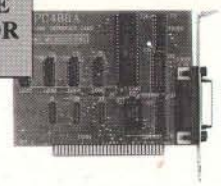

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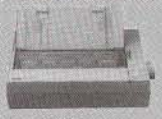

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421000A9B-10	1MB x 9	100ns	SIMM/PC	113.95
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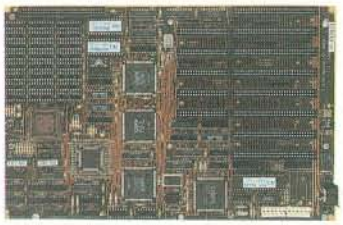

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THE FATHER OF COMPUTER GRAPHICS

Today's graphics systems owe their existence to an innovative graduate school project called Sketchpad

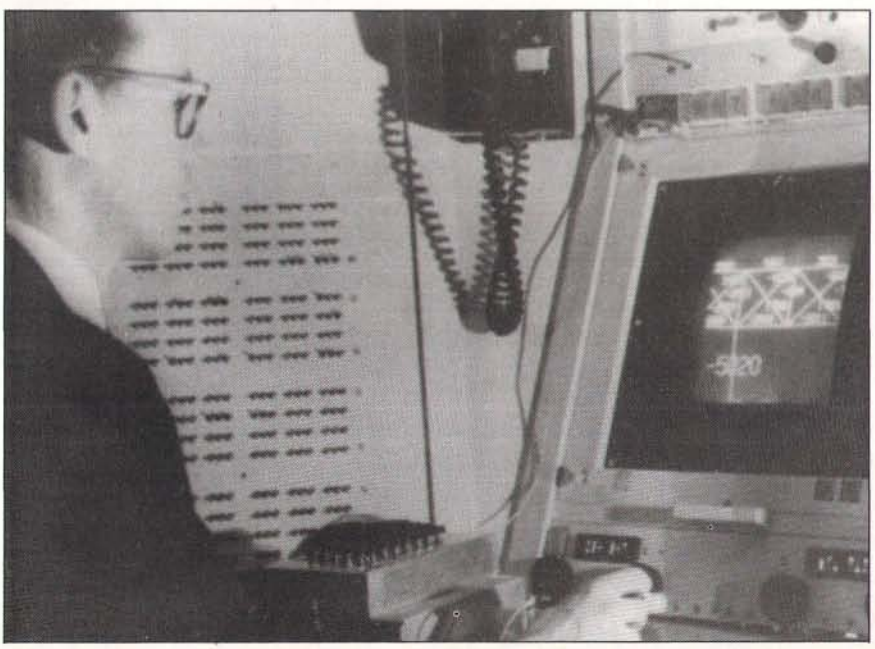
Don Bissell

Back in 1960, interactive computer graphics would have seemed like an improbable idea. In that year, computer operators typically positioned stacks of prepunched cards onto computers like the Whirlwind at MIT. The Whirlwind weighed 250 tons, powered 12,500 vacuum tubes, and filled a two-story house. But in 1960, all the elements needed for CAD to become a reality were in place.

The first element sprang from the development of the computer itself, which came in part from events surrounding World War II. In 1944, the U.S. government financed the construction of MIT's Whirlwind computer for national defense purposes. The Whirlwind introduced the first prerequisite for CAD—a CRT capable of displaying graphics.

In 1949, the Russian explosion of an atomic bomb stimulated the U.S. to fund Project SAGE (for Semi-Automatic Ground Environment). In time, the SAGE computer linked all North American radar sites. Its operators used a hand-held photocell, or "light gun"—the precursor to the light pen—to assign intercept aircraft targets (Soviet bombers) represented symbolically on the CRT. The second piece of the CAD puzzle was in place.

The Sputnik launch of 1957 generated further interest and financial support for computer research. Researchers at MIT's Lincoln Laboratories developed the TX-0 and later the TX-2



Ivan Sutherland, shown with his archetypical graphics system, Sketchpad, is considered the father of interactive graphics.

PHOTO COURTESY OF SUTHERLAND, SPROULL, AND ASSOC., INC.

computer, which had twice the memory of any computer of its day. Equipped with numerous switches, knobs, a keyboard, a point-plotting display, and a light pen, the TX-2 had from the first been designed to facilitate human-machine interaction. This was the third and final element essential to the development of CAD.

The atmosphere of academic freedom at MIT allowed some nontraditional research to take place: Graduate students began playing Space War—the first computer game—on the giant TX-2 computer. The game impressed at least one of the students with the immense possibilities presented by real-time interaction with the computer. That student was Ivan Sutherland, who used the TX-2 to bring together all the elements necessary for CAD in his doctoral thesis, "Sketchpad: A Man-Machine Graphical Communication System."

The cornerstone of Sutherland's thesis was a film that showed him using Sketchpad on the TX-2 computer to sketch a bolt. A light pen provided the coordinates corresponding to the drawing commands entered on the keyboard. Sketchpad allowed Sutherland to recall previously drawn display primitives (e.g., circles and polygons) to the screen. He was then able to rotate, scale, copy, and erase these primitives. The light pen let him edit existing drawing entities. Smaller versions of master drawings were described as "instances" of the parent drawing. Drawings created by Sketchpad could be stored on magnetic tape. Many of the computer's switches were assigned functions, such as move and draw. In short, Ivan Sutherland's Sketchpad was a complete and working CAD software package.

The "Robot Draftsman," as Sketchpad was later called, illustrated the potential of computer graphics and inspired almost all who viewed it. The idea that people no longer had to become expert programmers to use the computer effectively was novel and exciting. Now users could produce graphics in real time and observe instantaneous results. Numerous scientists chose interactive computer graphics as a career field as a result of viewing Sketchpad.

An immediate effect of Sketchpad's influence was heavy investment in computer graphics R&D by both military and commercial organizations. Today's CAD system has benefited from the innovation of numerous contributors. IBM, for example, provided credibility to the infant CAD industry with the announcement of the IBM 2250, which added the concept of vector CAD to computer graphics. In 1966, Lockheed-Georgia used computer graphics to create a numerically controlled machined part. Then came the Alto, an innovative stand-alone system developed at the Xerox Palo Alto Research Center in California, inspired in part by Sketchpad. (Many now say that the Alto provided the most significant advancement in computer graphics.) In 1970, Ivan Sutherland developed view clipping and perspective projection to further enhance CAD.

Sketchpad was not one isolated discovery; it was an entire methodology. Many brilliant scientists and engineers have contributed to advances in computer architecture, I/O devices, and display technology, and these contributions are still ongoing. But in bringing together the pieces for the archetypical CAD system, Dr. Ivan Sutherland set the stage for the $1.6 billion CAD industry of today. For this remarkable achievement, he is rightfully known as the "Father of Computer Graphics." ■

Donald Bissell is a CAD designer at the Portsmouth Naval Shipyard in Portsmouth, New Hampshire. He is also a CAD consultant and is currently working on a book on the origins of CAD. He can be reached on BIX c/o "editors."

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

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Hugh Kenner

In Darkest Self-Similarity

A spate of new books—and a couple of classics—point out that fractals are everywhere, even in publishing

Under *fractal*, the second edition (1989) of the *Oxford English Dictionary* now offers an elegant definition: "A mathematically conceived curve such that any small part of it, enlarged, has the same statistical character as the original." Good. The *OED* having spoken, *fractal* is officially part of the language.

Strictly speaking, the word is an import from French, the language Benoit Mandelbrot was using when he made it up. He recalls making it from the Latin *fractus*, broken. To see the connection with brokenness, reflect that a circle can't be a fractal, because if you enlarge a small enough part of it, you might as well be looking at a straight line. But enlarge a portion of a jagged rock, and, lo, a rocky mountain.

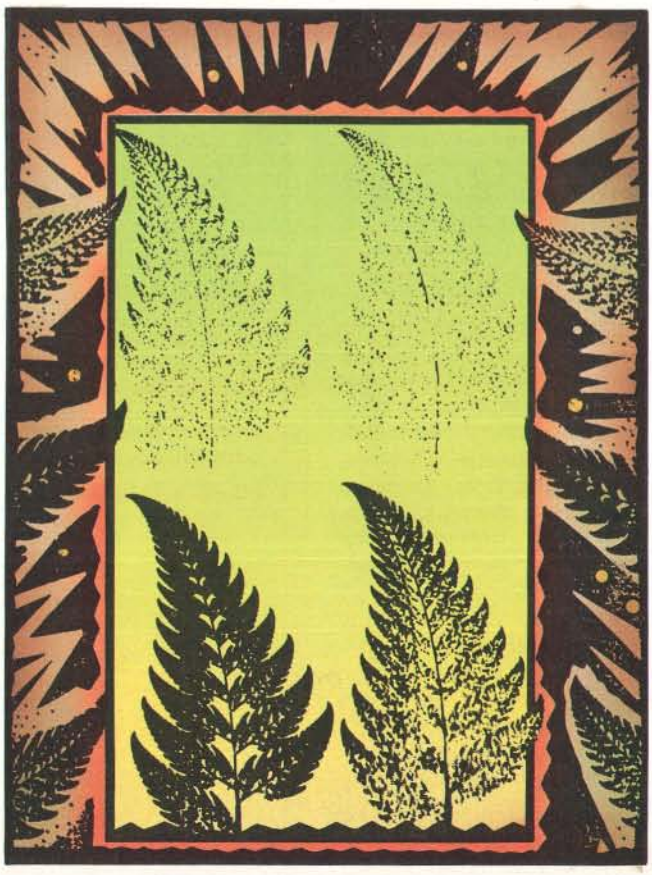
In Paris, Mandelbrot's *Les Objets Fractals* (1975) has just reached its third (1989) edition, with an engaging 50-page "Survol" (Overview) appended (Flammarion, 99 francs). In New York, the second edition of his gloriously illustrated *The Fractal Geometry of Nature* (1982, W. H. Freeman, $39.95) is due out in October of this year. Next came H. O. Peitgen and P. H. Richter's 1988 *The Beauty of Fractals: Images of Complex Dynamical Systems* (Springer-Verlag, $39), including a sketchy do-it-yourself appendix for programmers.

Michael Barnsley's *Fractals Everywhere* (1988, Academic Press, $39.95) is essentially a college-level text; *The Science of Fractal Images* (1989, Springer-Verlag, $39.95), which is edited by Peitgen with Dietmar Saupe, has eight contributors, including Mandelbrot (twice), and algorithms aplenty.

Now add Clifford Pickover's *Computers, Pattern, Chaos and Beauty* (1990, St. Martin's, $29.95) and two books by Roger Stevens for IBM PC users: *Fractal Programming in C* (1989) and *Fractal Programming in Turbo Pascal* (1990) (M&T Books, each $29.95, or $10 more with a source code disk included). The chronology does limn a pattern.

Fifteen years ago, *Les Objets Fractals* argued for the unity and pertinence of the brand-new fractal concept. But its discoveries have never been free from computer dependence, and people who saw fractal images wanted to make such images. Until the mid-1980s, that meant access to a mainframe. We forget how recent hardware leaps have been. An early monochrome image showing a detail of a Mandelbrot set (*The Beauty of Fractals*, page 152) is pathetic even for monochrome.

Even at IBM's Yorktown Center, Mandelbrot himself had no access to color before about 1980. IBM PC graphics were initially miserable; I still use my old bit-mapping Zenith Z-100 for this kind of work, though it's confined to just eight colors, including black. But EGA and VGA boards have recently been opening the PC gates. Hence the most recent books.



Computer dependence? Partly because fractal concepts are most accessible to the eye, which means graphics; more important, because many of them depend on iterative equations, which mean *work*. Start with inputs that may say where a point is on the screen; crunch numbers till a result emerges; feed that result back into the equation; repeat until the result either settles down or gives signs that it's never going to. Assign the result a color. Turn the point on.

That can mean 100 or 1000 iterations; so for pencil and paper, one point could take all day. And we're thinking of 100,000 points or more. If the equation isn't too nasty, a mere 5-MHz computer can chew them at perhaps 200 points per second.

"You can't prove anything with a computer!" cried an objector. "True," said Mandelbrot, "But playing with a computer is a source of conjectures, often unexpected ones." Programs, anyone?

Although the Amiga's

ILLUSTRATION: CHRIS SPOLLEN © 1990

graphics capability would seem to make it an ideal fractal machine, nothing really elaborate seems to be available yet. My contacts suggest starting with MANDELVROM20.ZOO, available on BIX in "amiga.user/ listings." Lacking the hardware, I can't report firsthand.

If you have a PC and a subscription to BIX, your quickest recourse is to download from "graphic.disp/listings" a little wonder called FRAINT.EXE. Then run it, being sure to have plenty of disk space available, since what it does is unpack some 400,000 bytes of files. These include a document file and a program called FRACTINT.EXE. (If you copy the lively 46-page document file to your printer, be advised of my one complaint: no page breaks. Use DOS's PRINT with the /P:60 switch.)

Normal straight lines to normal jagged contours: That is one short way to say where fractals take us. And to star maps and diamond maps and a PC screen.

FRACTINT is the two years' work of a merry crew loosely coordinated by Bert Tyler (who is also on BIX). At the heart of FRACTINT is inspired reliance on quick integer rather than slow floating-point calculation. It works on a whole menu full of graphics systems. (Even chunky images on a four-color CGA are interesting.) The current version—11.0 as I write—includes Mandelbrot sets, Julia sets, Lorenz attractors, Newton iterations, Sierpinsky gaskets—in short, most of the fractal buzzwords, even Pickover's popcorn. And it's public domain. The 16-odd authors spell out a contribution policy: "Don't want money. Got money. Want admiration."

(Make "admiration" ironic, the way I think they mean it, and you've got something Mandelbrot would applaud. He distinguishes science done for the sake of doing it from science done for the status it can bring. Those lads are doing it for the sake of doing it.)

They get my admiration. The speed with which FRACTINT displays, say, the basic Mandelbrot set is incredible. As anyone who's played with it knows, that set can cost aeons of time in its huge central black hole, reiterating hundreds of times, only to discover that a point needn't be turned on after all. One of the FRACTINT crew (Mark Peterson) spotted a black-hole "periodicity loop" in *The Beauty of Fractals*, moreover, on pages 58–60, where the math is heavy. A detector for that loop proved cheap and *fast*; the program now skims across blackness like Katarina Witt across ice.

Or, if you've a C or Turbo Pascal (version 4 or higher) compiler, you can use the DOS disks that can be obtained with the Roger Stevens books. (Don't even think of entering all that code by hand.) The disks contain source code only, and getting that to run may need a little tinkering. The Pascal version depends on a fractal unit you compile separately, and my version 5.5 compiler balked until I'd inserted {$N+} to say I wasn't expecting a numeric coprocessor chip. That's odd, since Stevens defers until as late as page 442 a mild afterthought to the effect that you might find such a chip helpful.

The overlap between Stevens's books and FRACTINT is considerable but not total; if Stevens lacks popcorn and trigonometric Mandelbrot, FRACTINT lacks Hilbert curves and assorted landscapes—trade-offs like that.

As for what it all means, if I could choose just two books, I'd say Mandelbrot's *The Fractal Geometry of Nature* (after all, the present-at-the-creation text) and *The Science of Fractal Images*, diverse and explicit. The Mandelbrot book, it's been asserted, is not for everybody. True. But it's broken into typographical chunks, many of which are for anyone literate. Whenever the deeper math glazes your eyes, skip along. You'll come to a paragraph like this:

"And the distribution of raw diamonds in the Earth's crust resembles the distribution of stars and galaxies in the sky. Consider a large world map on which each diamond mine or diamond rich site . . . is represented by a pin. When examined from far away these pins' density is extraordinarily uneven. A few are isolated here and there, but most concentrate in a few blessed (or accursed) areas. However, the Earth's surface in these areas is *not* uniformly paved with diamonds. When examined more closely, any of these areas turns out itself to be mostly blank, with scattered subareas of much greater diamond concentration. The process continues over several orders of magnitude."

Now recall what I quoted from the *OED* earlier: "any small part of it, enlarged, has the same statistical character as the original." Here's one more astonishing instance. The earth-wide distribution of raw diamonds is fractal. So is the cosmos-wide distribution of galaxies. Since what diamonds have to do with galaxies—for that matter, with coastline lengths or River Nile discharges, to mention two other examples—is not evident, it seems we may be glimpsing a deep law.

And in *The Science of Fractal Images*, here's Michael Barnsley, released from textbook constraints, eschewing our long obsession with straight lines. He quotes Sir Kenneth Clark on landscape painting: "The leaves, flowers and tendrils of Rheims and Southwell, which, in the later twelfth century, break through the frozen crust of monastic fear, have the clarity of newly created things."

So have Barnsley's Iterated Function Systems images, which use fractal self-similarity to store images in a fragment of the bit space we'd otherwise expect. (The trade-off is the time that reconstruction takes.) The cover picture on his *Fractals Everywhere*—a color photo of a girl under a hat—was stored in what he calls "under 160 maps," using self-similarities like the two sides of a face. But release from Euclid's straight lines is his generic theme. Such lines dominated, so Barnsley reminds us, both Rome's roads and Leibniz's calculus.

Normal straight lines to normal jagged contours: That is one short way to say where fractals take us. And to star maps and diamond maps and a PC screen. ■

Hugh Kenner is a professor of English at Johns Hopkins University. His reviews have appeared in publications like the New York Times *and* Harper's. *His recent books include* A Sinking Island *and* Mazes. *He can be contacted on BIX as "hkenner."*

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

THE FLIGHT OF THE BEE WOLF

Compared to this humble insect, a cruise missile is downright stupid

Today, multiprocessor microcomputers handle hundreds of tasks at virtually the same time. Desktop workstations perform operations that are more complex than those performed by room-size mainframe computers five years ago—and they do it faster. We are using AI systems in real applications without expenditures of millions of dollars. It seems that we are entering the age of truly intelligent systems.

But consider the bee wolf. This seemingly insignificant creature is a bee-hunting fly that tunnels its single-occupancy home in beach sand. Even though hundreds of bee wolves have their tunnels in the same area of a beach, each bee wolf will return to its own home and no other.

A biologist covered the opening of one bee wolf's tunnel with sand to see what the insect would do when it returned and found no tunnel. Without hesitation, the bee wolf went to the location of its entry and began digging.

The biologist noted that each time the bee wolf left for a hunt, it would fly a pattern above its home before departing. The creature appeared to be memorizing landmarks. The biologist tested his theory (not to mention the bee wolf's patience with biologists) by sketching the layout of pinecones around the entrance while the unsuspecting subject was at home. Soon the bee wolf emerged from the tunnel and flew its pattern before heading out in search of prey. Once the bee wolf had departed, the researcher moved the array of pinecones over about a half-meter.

When the bee wolf returned, it attempted to find its private cave at the center of the relocated pinecones. It dug in the sand for a second or two but found no tunnel.

Unlike members of our species, the bee wolf did not call its lawyer, psychiatrist, or parish priest. Instead, it realized that something was amiss and flew a higher pattern over the territory. From this new perspective, it was able to discard the erroneous references to pinecones and promptly located the true entrance.

The first computer analogy to this recognition and guidance problem is in a military application. The self-navigating cruise missile uses a system called terrain-contour matching (TERCOM). Inside the cruise missile's guidance computer is a set of computer-encoded maps of checkpoints along the programmed flight plan. At these checkpoints, the TERCOM computer compares readings of a radar altimeter with a contour map stored in its memory. If the computer finds no match between the expected data and the real data, it searches for a match with the map of the surrounding area. Once the match is found, the computer adjusts the course of the missile to account for the error.

To fool the cruise missile, you just move the target, leaving behind a dummy target. Because the cruise missile destroys itself in the process of destroying its target, it never can discover that it has made a mistake.

Even though the flight-control computer in the missile weighs less than 100 pounds, it has the equivalent of millions of transistors. Producing each of these computers costs a good part of a million dollars. In contrast, the bee wolf's brain, which is no bigger than the head of a pin, must carry on far more complex operations than just finding its host's way home. It must provide control to an aerodynamically instable machine, its body. The bee wolf also can walk, dig, locate and outmaneuver its prey, and find a mate (a task that would be disastrous for a cruise missile). Compared to the bee wolf, the cruise missile is downright stupid.

Many people falsely place computers in a scale of intelligence well beyond that of the human mind. But even a person with severe learning disabilities performs far more complex mental operations in a far shorter time than the largest and fastest computer. What size computer and program could control a walking robot that could rise from a chair, put on a coat, go outside, walk around the building on rolling terrain, establish the location of the entrance from visual information, and reenter the building—all this, while maintaining respiration, blood flow, and the input from millions of sensors for pressure, temperature, light, sound, and chemical analyses and production? Now consider the scope of the human brain. How much data is represented by all the memories in just one human being? What complex relationship exists between memories to create knowledge?

From this perspective of information processing, you must admit that computers are merely sophisticated adding machines. Even when this year's high-performance machines outperform last year's model by an order of magnitude, they are still not noticeably closer to the performance of the humble bee wolf's brain, let alone the performance of the human mind. ■

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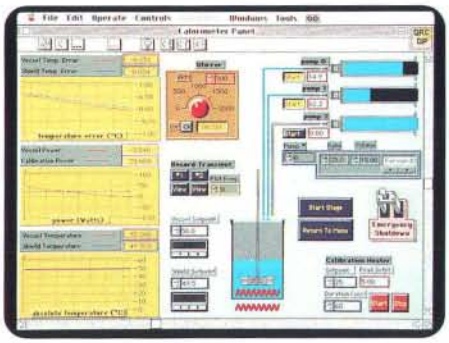

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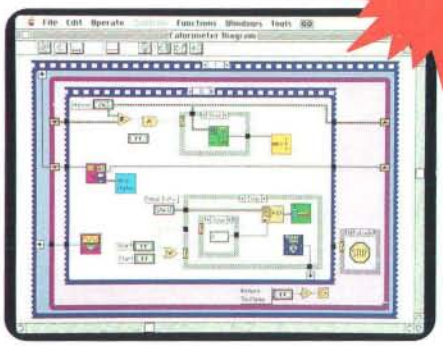

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